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YIELDS OF DIFFERENT VARIETIES OF CORN IN ILLINOIS

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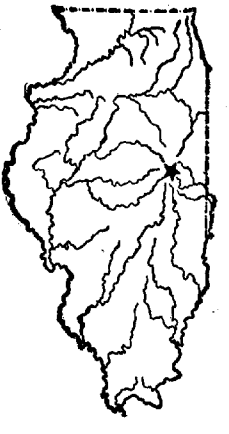


URBANA, ILLINOIS, AUGUST, 1916

Summary of Bulletin No. 191

Northern Illinois.—Continued tests have shown that Western Plowman is the highest-yielding variety of corn for northern Illinois. The other leading high-yielding varieties which have been grown for a minimum of four years are: Riley's Favorite, Griffith's Early Dent, Reid's Yellow Dent, Hecker's Red, and Funk's 90 Day. Pages 409-413

Central Illinois.—At Urbana, seventeen varieties of corn have been under test for five years or more. Reid's Yellow Dent has given the highest yield of any variety grown for a minimum of five years. Boone County White, Learning, Silvermine, Riley's Favorite, Champion White Pearl, Golden Eagle, Farmer's Interest, Johnson County White, and Beatty's Yellow are other high-yielding strains commonly grown. Pages 411-418

Southern Illinois.—On well fertilized land in southern Illinois, Funk's 90 Day has given the highest yield of any variety which has been tested for four years or more. The other leading high-yielding varieties tested on fertilized land for a minimum of four years are Reid's Yellow Dent, Perrine's White Pearl, and Chinese Poor Land. On untreated land, Champion White Pearl, Perrine's White Pearl, and Easterly's White have been the highest yielders for three years (1911-1913). Pages 418-422

A Brief History of Certain Varieties of Corn. Pages 422-424

YIELDS OF DIFFERENT VARIETIES OF CORN IN ILLINOIS

By W. L. BURLISON, Associate Chief in Crop Production, and O. M. ALLYN, First Assistant in Crop Production

This bulletin is prepared for corn growers who are interested in the comparative yielding powers of new and old varieties of corn grown in the three principal sections of Illinois. It is not possible to say which is the best variety of corn for each section of the state, but the report herein presented cannot fail to be of value in making a choice. The data included represent the results of about fifteen years' investigations conducted, for the most part, at DeKalb, in DeKalb county; Urbana, in Champaign county; and Fairfield, in Wayne county, Illinois. This publication should not be regarded as final, but simply as a report of the progress of the work and the results thus far obtained.

The state of Illinois is characterized by wide differences in climate and soil. Therefore, varieties of corn suited to one locality are not necessarily the most desirable for another. From north to south, the extreme length of the state is about 380 miles. The rainfall for northern Illinois is 33.64 inches per year; for central Illinois, 35.76 inches per year; and for southern Illinois, 40.25 inches per year. The length of the growing season for the northern section is 166 days; for the central section, 173 days; and for the southern section, 188 days, as an average.

The soil on which the experiments at DeKalb and Urbana were conducted, is brown silt loam; at Fairfield, gray silt loam on tight clay. These fields have been regularly supplied for the most part with phosphate rock, limestone, and either farm manure or crop residues. The aim has been to keep the land in a good state of fertility but not to produce abnormal conditions. It is believed that these fields are such as any progressive Illinois farmer would maintain. Methods of culture have been followed which are strictly comparable to those used by leading corn growers. Thus the yields reported are no larger than may well be expected from the respective sections of Illinois.

NORTHERN ILLINOIS

Tests at Myrtle and Sycamore, in Ogle County

Variety tests of corn were started at Myrtle, in Ogle county, in 1903. The work was continued thru the season of 1904 and was then moved to Sycamore, in DeKalb county. In 1906 the northern Illinois crop field was established at DeKalb, in the same county, and the work was moved to that field, where it has been conducted up to the present

time. The predominating soil type on which these tests were conducted is brown silt loam, the leading type on which corn is grown in northern Illinois. The results obtained at Myrtle and Sycamore are summarized in Table 1.

TABLE 1.—AVERAGE YIELDS OF VARIETIES GROWN AT MYRTLE AND SYCAMORE: 1903-1905

(Bushels per acre)

Variety	Myrtle 1903	Myrtle 1904	Sycamore 1905	Average yield
Riley's Favorite	57.2	45.5	59.6	54.1
Reid's Yellow Dent	59.5	46.9	54.4	53.6
Funk's 90 Day	55.6	42.9	62.3	53.6
Leaming	54.4	40.3	63.4	52.7
Goldmine	52.2	45.7	59.8	52.6
Pride of the North	52.0	46.5	51.4	50.0
Boone County White	52.1	37.8	58.4	49.4
White Superior	...	47.9	59.4	...
Western Plowman	...	45.5	61.0	...
Champion White Pearl	...	...	61.6	...
Silvermine	56.9	...	...	...
Golden Eagle	56.3	...	...	...
Farmer's Interest	...	34.1	...	...
Lockwood's Yellow Dent	...	...	62.2	...

Western Plowman was not grown at Myrtle in 1903, and a three-year average therefore cannot be given for it, as for the first seven varieties listed in Table 1. However, when it is compared on an equal basis with Riley's Favorite, Reid's Yellow Dent, and Funk's 90 Day, using the 1904 and 1905 yields, it out-yielded them, as shown by the following direct comparisons:

	2-year average *Bu. per acre*
Western Plowman	53.3
Riley's Favorite	52.6
Reid's Yellow Dent	50.7
Funk's 90 Day	52.6

White Superior, Champion White Pearl, and Lockwood's Yellow Dent, altho showing yields slightly higher than Western Plowman for the years in which they were grown, are considered undesirable for northern Illinois because of their late maturity.

At Myrtle in 1904 and at Sycamore in 1905, the average shrinkage of White Superior was 6.4 percent greater than that of Western Plowman at the same places and the same time. At Sycamore in 1905, the average shrinkage of Lockwood's Yellow Dent was 22.2 percent, and that of Champion White Pearl was 19.7 percent, as compared with 11.5 percent for Western Plowman. However, the yields reported have been computed to a uniform moisture content of 10.7 percent, and are thus strictly comparable.

TESTS AT DEKALB, IN DEKALB COUNTY

The variety tests of corn at the DeKalb field have been conducted, in the main, in a rotation of corn, corn, oats, and clover. Each year, beginning with 1908, the varieties were duplicated in each division containing corn. In each division two systems of farming were practiced —namely, grain and live-stock; and each variety was grown in each system of farming in each division. Thus, normally, each variety was tested under four conditions each year, and the average yields of the varieties for the season were made from these four tests.

Since the highest average yield of a variety does not always indicate the best variety, and in order to establish more definitely the relation of the different varieties with respect to yield, all are compared on the same basis, with Western Plowman as a standard. This at once gives a definite rating of the different varieties when compared with a leading variety.

A summary of the varieties tested at DeKalb from 1907 to 1915 appears in Tables 2 and 3, which present fairly conclusive data as to the higher-yielding and more important varieties.

When the basis of comparison is equal with respect to the numbers of years tested, Western Plowman has never been out-yielded by any variety at DeKalb except by Will County Favorite, which has been tested only two years and is the same variety by origin.

As may be seen in looking over Tables 2 and 3, only the most important varieties have been included in the latter table. The principal high-yielding varieties which have been grown for a minimum of four years are: Western Plowman, Riley's Favorite, Griffith's Early Dent, Reid's Yellow Dent, Hecker's Red, and Funk's 90 Day.

CENTRAL ILLINOIS

TESTS AT URBANA, IN CHAMPAIGN COUNTY

Variety trials on the Urbana field reported in this bulletin have been conducted since 1901. The results given have been obtained from the various trials of corn grown in three rotations as follows:

(1) Corn, corn, oats, and clover
(2) Wheat, corn, oats, and clover
(3) A combination rotation of alfalfa, corn, potatoes, and soybeans

For the most part, the yields are based on a grain and a live-stock system of farming.

The leading varieties are compared with Reid's Yellow Dent as a standard, on the percentage basis. Such a rating renders it possible to make a direct comparison of a given group of tests. The complete data are reported in Table 4. A summary of the Urbana variety trials

TABLE 2.—AVERAGE YIELDS OF VARIETIES GROWN AT DEKALB, AND PERCENTAGE RATING USING WESTERN PLOWMAN AS A STANDARD: 1907-1915

(Bushels per acre)

Variety	1907	1908	1909	1910	1911	1912	1913	1914	1915	Percentage rating of varieties
Western Plowman	60.6	66.2	75.4	60.4	70.1	66.3	57.1	79.8	39.6	100.0
Funk's 90 Day	44.6	54.6	63.1	64.7	64.0	67.3	60.6	70.8	35.4	91.2
Leaming High Ears	28.6	44.2	56.6	44.6	43.9	54.1	45.7	42.3	13.7	64.9
Leaming Low Ears	29.3	59.4	55.1	46.1	70.5	51.1	39.2	64.0	34.8	78.1
Leaming	...	53.5	63.1	58.7	61.1	59.3	59.4	...	...	89.8
Reid's Yellow Dent	...	51.1	68.5	56.4	69.5	67.0	58.2	...	34.6	93.1
Silvermine	38.1	50.2	62.9	62.3	67.9	59.7	50.3	72.2	...	86.6
Hackberry	40.1	63.9	54.8	49.1	...	...	...	...	...	79.1
Graves' Yellow Dent	26.6	...	62.4	58.0	63.8	70.3	52.5	...	...	85.5
Early Golden Surprise	34.1	54.9	...	56.2	58.2	64.3	57.6	...	...	85.4
Griffith's Early Dent	...	...	60.9	61.3	67.7	59.0	...	..	41.2	93.4
Wisconsin No. 7	...	...	...	43.7	60.0	57.6	57.7	57.5	...	82.9
Hecker's Red	...	...	...	...	61.6	60.3	63.0	63.7	42.6	93.0
Riley's Favorite	...	...	...	...	...	65.0	74.1	67.3	29.4	97.2
Lockwood's Yellow Dent	37.0	33.5	...	...	...	...	...	...	...	55.7
Will County Favorite	...	...	...	...	...	...	...	79.3	40.9	100.7
Perrine's White Pearl	...	50.0	59.0	...	...	...	...	...	...	77.0
Champion White Pearl	..	42.4	51.0	...	...	...	...	...	...	66.0
Strout's Red	...	...	...	...	...	...	...	76.4	37.6	95.5
Hunt's Yellow Dent	51.8	...	...	...	...	...	...	...	...	....
Funk's Boone County White	25.4	...	...	...	...	...	...	...	...	....
Golden Eagle	...	...	...	...	...	...	51.4	...	...	....
Northern Grown Leaming	...	...	...	...	...	...	...	69.7	...	....
Murdock's Yellow Dent	...	...	...	...	...	...	...	60.1	...	....
Golden Glow	...	...	...	...	...	...	...	59.0	...	....
Sutton's Favorite	...	...	...	...	...	...	...	...	24.2	....
Golden King	...	...	...	...	...	...	...	...	35.8	....
Native White	...	...	...	...	...	...	...	...	40.6	....
Flint Corn	29.6	...	...	...	...	...	...	...	...	....

TABLE 3.—COMPARABLE AVERAGE YIELDS OF VARIETIES GROWN AT DEKALB USING WESTERN PLOWMAN AS A STANDARD: 1907–1915
(Bushels per acre)

Variety	Total number of tests	Number of years compared	Years on which comparison is based	Average yield
Western Plowman.....	36	9	1907–1915 inclusive	63.9
Funk's 90 Day.....	33	9	" " "	58.3
Leaming High Ears...	33	9	" " "	41.5
Leaming Low Ears....	33	9	" " "	49.9
Western Plowman.....	28	8	1907–1914 inclusive	67.0
Silvermine	30	8	" " "	58.0
Western Plowman.....	30	7	1908–1915 inclusive except 1914	62.2
Reid's Yellow Dent...	38	7	" " " " "	57.9
Western Plowman.....	33	6	1907–1913 inclusive except 1908	65.0
Graves' Yellow Dent..	21	6	" " " " "	55.6
Western Plowman.....	22	6	1908–1913 inclusive	65.9
Leaming	24	6	" " "	59.2
Western Plowman.....	20	6	1907–1913 inclusive except 1909	63.5
Early Golden Surprise.	22	6	" " " " "	54.2
Western Plowman.....	23	5	1909–1915 except 1913 and 1914	62.4
Griffith's Early Dent..	20	5	" " " " " "	58.3
Western Plowman.....	19	5	1910–1914 inclusive	66.7
Wisconsin No. 7.....	20	5	" " "	55.3
Western Plowman.....	23	5	1911–1915 inclusive	62.6
Hecker's Red	20	5	" " "	58.2
Western Plowman.....	20	4	1912–1915 inclusive	60.7
Riley's Favorite	20	4	" " "	59.0
Western Plowman.....	13	4	1907–1910 inclusive	65.7
Hackberry	14	4	" " "	52.0
Western Plowman.....	12	2	1914–1915 inclusive	59.7
Will County Favorite[1].	8	2	" " "	60.1
Western Plowman.....	12	2	1914–1915 inclusive	59.7
Strout's Red	8	2	" " "	57.0
Western Plowman.....	7	2	1908–1909 inclusive	70.8
Champion White Pearl.	8	2	" " "	46.7

[1]Will County Favorite is practically the same as Western Plowman. Both originated in the same way. See history of Western Plowman, page 424.

from 1901 to 1915 is given in Table 5. The yields are calculated to a uniform moisture content of 10.7 percent. Reid's Yellow Dent, Boone County White, Champion White Pearl, Leaming, Silvermine, and Riley's Favorite are leading varieties for central Illinois. Other high yielding strains commonly grown are Golden Eagle, Farmer's Interest, Johnson County White, and Beatty's Yellow.

OTHER CENTRAL ILLINOIS TESTS

In 1903 variety tests were conducted at Decatur, in Macon County; Auburn, in Sangamon county; and Sibley, in Ford county. The work

TABLE 4.—AVERAGE YIELDS OF VARIETIES GROWN AT URBANA, AND PERCENTAGE RATING USING REID'S YELLOW DENT AS A STANDARD: 1901–1915

(Bushels per acre)

Variety	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	Percentage rating of varieties
Leaming	41.3	79.6	39.6	57.0	59.0	91.1	57.6	62.8	68.0	59.8	19.8	77.9	50.5	68.5	56.1	95.5
Boone County White	47.3	78.2	43.7	54.5	70.4	93.2	63.4	64.8	64.3	66.1	18.3	79.8	46.4	66.1	48.1	97.3
Reid's Yellow Dent	46.1	80.0	46.4	71.6	66.8	82.9	70.7	69.3	65.5	57.1	22.8	85.3	48.4	61.6	55.3	100.0
Silvermine	43.9	72.2	34.0	53.7	68.9	75.7	61.1	57.3	62.4	63.0	20.7	80.5	46.8	63.5	57.3	92.6
Champion White Pearl	51.1	...	...	...	71.6	92.8	55.9	71.4	59.4	54.7	17.8	76.0	37.6	50.3	52.4	94.4
Riley's Favorite	38.7	69.7	30.2	58.5	66.6	79.6	61.9	63.3	66.6	49.4	18.5	77.1	49.3	58.2	54.3	90.5
Golden Eagle	47.7	72.0	45.6	46.4	65.3	77.7	74.3	...	...	45.8	14.9	75.3	41.5	44.9	42.8	87.3
Illinois High Protein	...	...	27.2	30.9	56.6	65.1	51.4	51.3	50.4	41.7	8.9	59.4	36.0	40.4	48.5	70.6
Illinois Low Protein	...	...	37.7	55.5	60.6	73.2	61.8	53.3	66.2	50.1	17.8	79.9	47.9	57.6	52.2	88.8
Illinois High Oil	...	...	32.7	41.9	58.4	66.0	52.6	61.6	53.7	47.5	8.5	69.9	39.0	44.5	52.2	76.9
Illinois Low Oil	...	...	41.2	40.5	58.1	83.0	49.7	38.0	51.9	48.9	13.2	73.0	41.7	54.2	48.6	79.8
Leaming Low Ears	...	...	...	...	...	72.6	61.0	53.6	59.1	48.0	16.2	70.9	45.3	49.1	58.8	86.4
Leaming High Ears	...	...	...	...	...	72.4	54.1	58.2	56.6	38.4	7.0	65.4	31.7	40.2	37.0	74.5
Johnson County White	...	77.9	47.1	...	...	...	...	...	52.7	60.3	23.3	...	...	...	...	96.1
Stamey's White	...	...	51.3	64.7	68.4	...	...	...	...	...	...	...	...	...	...	99.8
Chinese Poor Land	...	...	50.7	41.8	78.6	88.4	81.0	51.0	45.5	40.3	16.1	...	...	...	...	89.2
Farmer's Interest	47.9	...	47.1	50.1	72.7	95.3	...	...	...	...	...	...	...	...	...	99.8
Funk's 90 Day	...	81.7	41.5	...	...	...	...	...	...	57.9	24.2	...	...	...	...	99.4
Beatty's Yellow	...	...	46.2	...	64.0	84.4	65.3	57.0	...	...	...	...	...	...	...	94.3
Gold Mine	...	65.1	32.9	37.0	...	...	...	...	...	...	20.7	...	...	...	...	70.5
Pride of the North	32.0	67.4	38.4	...	...	...	...	...	...	...	...	...	...	...	...	79.8
White Superior	50.0	...	...	45.8	75.1	...	...	...	...	...	...	...	...	...	...	92.5
Abbott's White	...	...	...	...	...	...	...	...	47.4	55.3	15.7	...	...	...	...	81.4
Graves' Yellow Dent	...	78.7	...	...	...	...	...	...	...	53.6	29.8	...	...	...	...	101.3
Yellow Prolific	...	...	...	...	...	...	...	...	...	54.9	26.5	...	...	...	...	102.0

TABLE 4.—*Concluded*

Variety	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	Percentage rating of varieties
Western Plowman	...	...	...	...	...	...	...	...	...	56.3	27.4	...	...	...	...	104.8
Will County Favorite	...	...	...	...	...	...	...	...	...	54.4	24.7	...	...	...	...	99.0
Burr's White	33.6	77.5	...	...	...	...	...	...	...	...	...	...	...	...	...	88.3
Wisconsin No. 7	...	...	...	...	...	...	52.5	...	...	...	21.7	...	...	...	...	79.3
Legal Tender	...	84.8	36.4	...	...	...	...	...	...	...	...	...	...	...	...	95.9
Funk's Calico	...	88.6	50.6	...	...	...	...	...	...	...	...	...	...	...	...	110.1
Mastodon	...	...	34.8	...	...	...	...	...	...	...	...	...	...	...	...	....
Minnesota No. 13	...	...	...	...	...	...	41.3	...	...	...	...	...	...	...	...	....
Griffith's Early Dent	...	...	...	...	...	...	...	...	...	...	27.8	...	...	...	...	....
St. Charles White	54.2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Edmond's Yellow Dent	33.6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Banner White	...	79.6	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Peerless White	...	76.6	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Pride of Nishua	...	73.3	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Pride of Illinois	...	74.4	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Funk's Yellow Dent	...	59.8	...	...	...	...	...	...	...	...	...	...	...	...	...	....
Golden Surprise	...	...	...	...	...	...	...	...	...	...	18.8	...	...	...	...	....
Hecker's Red	...	...	...	...	...	...	...	...	...	...	22.6	...	...	...	...	....

TABLE 5.—COMPARABLE AVERAGE YIELDS OF VARIETIES GROWN AT URBANA USING REID'S YELLOW DENT AS A STANDARD: 1901–1915

(Bushels per acre)

Variety	Total number of tests	Number of years compared	Years on which comparison is based	Average yield
Reid's Yellow Dent..	193	15	1901–1915 inclusive	62.0
Boone County White..	98	15	" " "	60.3
Leaming	95	15	" " "	59.2
Silvermine	80	15	" " "	57.4
Riley's Favorite	58	15	" " "	56.1
Reid's Yellow Dent..	170	12	1901 and 1905–1915 inclusive	61.0
Champion White Pearl	66	12	" " " " "	57.6
Reid's Yellow Dent..	171	13	1901–1907 and 1910–1915 inclusive	61.3
Golden Eagle	50	13	" " " " " "	53.4
Reid's Yellow Dent..	164	13	1903–1915 inclusive	61.8
Illinois High Protein	36	13	" " "	43.7
Illinois Low Protein..	36	13	" " "	54.9
Illinois High Oil.....	36	13	" " "	48.3
Illinois Low Oil.....	36	13	" " "	49.4
Reid's Yellow Dent..	157	10	1906–1915 inclusive	61.9
Leaming High Ears..	32	10	" " "	46.1
Leaming Low Ears...	32	10	" " "	53.5
Reid's Yellow Dent..	22	5	1901 and 1903–1906 inclusive	62.8
Farmer's Interest....	18	5	" " " " "	62.6
Reid's Yellow Dent..	130	5	1902, 1903, 1909–1911 inclusive	54.4
Johnson County White	20	5	" " " " "	52.3
Reid's Yellow Dent..	24	5	1903 and 1905–1908 inclusive	67.2
Beatty's Yellow	12	5	" " " " "	63.4
Reid's Yellow Dent..	132	9	1903–1911 inclusive	61.5
Chinese Poor Land...	19	9	" " "	54.8

at Decatur and Auburn was discontinued after 1903, but at Sibley it was continued until 1907, making a total of five years for this field. At Mattoon, in Coles county, the work was conducted during 1904 and 1905. The results of the tests are summarized in Table 6.

Of the fifteen varieties tested at the places mentioned in Table 6, Reid's Yellow Dent, on an equal basis of comparison (the same number of years at the same field), was out-yielded by three varieties; namely, Funk's Yellow Dent, Farmer's Interest, and White Superior. In any case, however, the difference was not marked, and not much reliance can be placed on the two years' results from these varieties.

In Table 7 are reported some of the results of the first test conducted in central Illinois to determine the yields of the more important varieties of corn then in use.[1] This test was started in 1888 at Urbana and continued until 1895. The yields are based on air-dry corn containing 11 percent of moisture. Boone County White, Champion White Pearl, and Leaming were then, as now, among the highest-yielding varieties.

[1]For original report see Bulletin 42 of this station.

TABLE 6.—AVERAGE YIELDS OF VARIETIES GROWN AT DECATUR, AUBURN, MATTOON, AND SIBLEY, AND PERCENTAGE RATING USING REID'S YELLOW DENT AS A STANDARD: 1903–1907

(Bushels per acre)

Variety	Decatur	Auburn	Mattoon		Sibley					Percentage rating of varieties
	1903	1903	1904	1905	1903	1904	1905	1906	1907	
Reid's Yellow Dent	52.6	45.9	48.5	58.6	87.8	70.4	61.8	48.8	27.9	100.0
Leaming	51.3	42.0	48.4	63.2	85.4	62.8	60.0	47.6	26.1	97.0
Boone County White	50.0	44.5	41.8	59.0	84.4	66.1	64.3	46.3	27.9	96.4
Silvermine	48.6	44.1	45.8	60.5	76.8	65.8	63.7	43.8	24.3	94.3
Golden Eagle	52.2	42.4	...	50.6	86.7	...	60.7	41.5	25.3	93.6
Funk's 90 Day	...	...	...	60.8	81.2	62.8	61.6	...	...	95.6
Riley's Favorite	...	...	...	...	79.2	62.4	64.2	42.2	23.9	91.7
Pride of the North	...	...	...	...	76.4	57.6	54.9	...	...	85.9
Beatty's Yellow	...	40.8	38.9	57.9	...	57.5	63.0	49.6	27.7	92.6
Funk's Yellow Dent	...	...	42.7	67.3	...	...	...	...	...	102.6
Farmer's Interest	...	...	48.7	58.2	...	...	65.0	47.7	...	100.9
Champion White Pearl	...	...	...	...	...	...	...	33.2	22.7	72.9
Chinese Poor Land	...	...	...	...	...	...	...	39.4	23.3	81.8
White Superior	...	...	...	...	...	66.3	67.2	...	...	101.1
Calico	...	...	...	...	...	66.8	...	...	...	....

TABLE 7.—AVERAGE YIELDS OF VARIETIES GROWN AT URBANA: 1888–1895
(Bushels per acre)

Variety	1888	1889	1890	1891	1892	1893	1894	1895	Average
Champion White Pearl.....	70.0	94.8	74.9	76.5	65.0	37.3	51.0	100.3	71.2
Leaming	86.6	80.6	69.4	67.3	70.1	34.6	62.1	80.0	68.6
Burr's White	85.9	75.7	67.7	67.7	64.2	38.6	69.7	79.2	68.6
Clark's Iroquois	68.5	81.9	59.0	65.4	72.9	30.7	44.3	102.5	65.6
Legal Tender	84.2	68.9	60.0	56.8	60.3	33.8	57.0	89.0	63.7
Murdock	80.3	65.0	61.6	59.8	57.6	35.7	48.1	85.9	61.7
Edmond's	83.7	66.3	55.9	58.6	58.4	28.3	54.3	86.1	61.4
Riley's Favorite	81.8	66.1	53.3	56.1	74.1	38.1	62.8	52.2	60.5
Boone County White.....	...	...	74.6	89.3	85.5	33.8	74.3	73.2	71.8
Golden Beauty	...	...	53.0	75.8	63.1	36.4	31.6	38.0	49.6

SOUTHERN ILLINOIS

TESTS AT FAIRFIELD, IN WAYNE COUNTY

Variety tests of corn in southern Illinois were started in 1906, when the southern crop field was established at Fairfield, in Wayne county. The field is located on gray silt loam on tight clay, which constitutes a large area of the southern third of the state and which is low in fertility. Live-stock and grain systems of farming were practiced on each division of the field; and, with respect to systems of farming and drainage, each of the varieties of corn was grown under each of four conditions each season.

A summary of the results of the tests at Fairfield from 1907 to 1915 appears in Tables 8 and 9. There are no data for 1914, when there was a failure of crops due to hot winds and drouth. Data for 1906 are excluded from the table because the yields were not calculated to the same moisture content as were those for 1907 to 1915. Table 9 shows for southern Illinois what Table 3 does for northern Illinois.

On a percentage basis, using Funk's 90 Day as a standard to which the other varieties are compared, the following, in the order named, yielded the highest for a minimum of four years: Funk's 90 Day, Reid's Yellow Dent, Perrine's White Pearl, and Chinese Poor Land. Other varieties, such as Sutton's Favorite, Strout's Red, Will County Favorite, and Western Plowman, which have been tested only one year, show a promising future. Continued experiment will establish their value.

RESULTS OF EXPERIMENTS ON UNTREATED LAND IN SOUTHERN ILLINOIS

In connection with the regular work on the crop field at Fairfield, additional tests were made on untreated land close to the field. The results indicate what one would naturally expect,—that varieties

TABLE 8.—AVERAGE YIELDS OF VARIETIES GROWN AT FAIRFIELD, AND PERCENTAGE RATING USING FUNK'S 90 DAY AS A STANDARD: 1907-1915

(Bushels per acre)

Variety	1907	1908	1909	1910	1911	1912	1913	1915	Percentage rating of varieties
Funk's 90 Day	57.8	38.4	33.9	71.0	28.6	49.7	5.1	43.5	100.0
Reid's Yellow Dent	64.8	33.3	36.0	68.4	27.4	42.3	4.0	42.5	97.1
Champion White Pearl	46.6	31.2	34.4	61.9	35.2	34.6	2.6	46.6	89.3
Silvermine	43.0	29.1	33.0	64.9	26.4	50.5	3.6	42.5	89.3
Leaming Low Ears	41.9	25.3	32.6	66.7	26.8	37.1	2.7	39.7	83.2
Leaming High Ears	34.1	28.3	26.8	57.4	18.2	36.1	.9	31.1	71.0
Perrine's White Pearl	52.2	30.9	33.9	67.4	30.0	49.3	2.0	...	93.6
Graves' Yellow Dent	49.5	29.1	32.6	66.4	33.2	41.2	3.8	...	89.9
Easterly's White	51.4	29.3	32.2	66.5	27.0	43.0	.4	...	87.9
Boone County White	45.4	30.2	...	61.4	29.1	39.3	2.0	44.0	85.5
Riley's Favorite	43.2	34.0	31.0	60.7	27.4	...	5.7	35.9	85.4
Chinese Poor Land	58.8	...	29.7	71.7	30.0	...	...	...	99.6
Golden Eagle	43.9	29.9	30.9	...	...	...	9.6	...	84.6
Native White	...	29.1	29.9	65.9	...	...	...	...	87.0
Leaming	...	...	...	...	...	49.1	2.5	...	94.2
Hickory King	30.2	...	...	...	...	...	...	...	....
Worthen's White	52.3	...	...	...	...	...	...	...	....
Red, White and Blue	...	...	...	...	...	41.1	...	...	....
Rinard's Native	...	...	...	...	...	49.8	...	...	....
Sutton's Favorite	...	...	...	...	...	...	...	47.0	....
Strout's Red	...	...	...	...	...	...	...	44.1	....
Will County Favorite	...	...	...	...	...	...	...	42.8	....
Western Plowman	...	...	...	...	...	...	...	42.6	....
Hecker's Red	...	...	...	...	...	...	...	37.8	....
Pride of the North	30.2	...	...	...	...	...	...	...	....

TABLE 9.—COMPARABLE AVERAGE YIELDS OF VARIETIES GROWN AT FAIRFIELD USING FUNK'S 90 DAY AS A STANDARD: 1907–1915

(Bushels per acre)

Variety	Total number of tests	Number of years compared	Years on which comparison is based	Average yield
Funk's 90 Day.....	30	8	1907–1915 except 1914	41.0
Reid's Yellow Dent...	30	8	" " " "	39.8
Champion White Pearl.	64	8	" " " "	36.6
Silvermine	30	8	" " " "	36.6
Leaming Low Ears....	29	8	" " " "	34.1
Leaming High Ears...	29	8	" " " "	29.1
Funk's 90 Day.....	26	7	1907–1913 inclusive	40.6
Perrine's White Pearl.	26	7	" " "	38.0
Graves' Yellow Dent..	26	7	" " "	36.5
Easterly's White	26	7	" " "	35.7
Funk's 90 Day.....	26	7	1907–1915 except 1909 and 1914	42.0
Boone County White..	26	7	" " " " " "	35.9
Funk's 90 Day.....	26	7	1907–1915 except 1912 and 1914	39.8
Riley's Favorite	26	7	" " " " " "	34.0
Funk's 90 Day.....	14	4	1907–1911 except 1908	47.8
Chinese Poor Land....	14	4	" " " "	47.6
Funk's 90 Day.....	14	4	1907–1909 inclusive and 1913	33.8
Golden Eagle	14	4	" " " " "	28.6
Funk's 90 Day.....	12	3	1908–1910 inclusive	47.8
Native White	12	3	" " "	41.6
Funk's 90 Day.....	8	2	1912 and 1913	27.4
Leaming	8	2	" " "	25.8
Funk's 90 Day.....	2	1	1907	57.8
Pride of the North....	2	1	"	30.2
Hickory King	2	1	"	30.2
Worthen's White	2	1	"	52.3
Funk's 90 Day.....	4	1	1912	49.7
Red, White and Blue..	4	1	"	41.1
Rinard's Native	4	1	"	49.8
Funk's 90 Day.....	4	1	1915	43.5
Sutton's Favorite	4	1	"	47.0
Strout's Red	4	1	"	44.1
Will County Favorite..	4	1	"	42.8
Western Plowman.....	4	1	"	42.6
Hecker's Red	4	1	"	37.8

grown commonly in southern Illinois and adapted to the soil out-yield those which give the best results under less adverse conditions. The results are presented in Table 10.

Further information on this point is obtained by examining the yields of Funk's 90 Day and Champion White Pearl produced in 1915 on treated and on untreated land, as presented in Table 11. At Newton, Champion White Pearl gave better returns on the untreated land than Funk's 90 Day, and on all the treated plots, except in one instance, it produced more corn than Funk's 90 Day. At Ob-

TABLE 10.—YIELDS OF VARIETIES ON UNTREATED LAND AT FAIRFIELD: 1911–1913
(Bushels per acre, 75 pounds of ear corn to the bushel)

Variety	1911	1912	1913	3-year average
Champion White Pearl	15.3	5.3	5.5	8.7
Perrine's White Pearl	11.0	6.6	6.7	8.1
Easterly's White	10.2	7.7	5.8	7.9
Reid's Yellow Dent	9.2	5.8	5.1	6.7
Boone County White	9.9	3.0	6.7	6.5
Funk's 90 Day	8.1	5.1	5.4	6.2
Silvermine	7.7	4.5	5.1	5.8
Graves' Yellow Dent	8.7	3.9	4.4	5.7
Leaming Low Ears	7.0	3.1	4.2	4.8
Riley's Favorite	8.4	..	6.0	..
Leaming	...	7.4	4.6	..
Rinard's White Prolific	12.8	..	..	..
Chinese Poor Land	12.2	..	..	..
Rinard's Yellow Prize Winner	11.9	..	..	..
Red, White and Blue	...	5.5	..	..
Golden Eagle	...	..	5.1	..
Leaming High Ears	...	4.0	..	..
Rinard's Native	...	4.0	..	..

TABLE 11.—AVERAGE YIELDS OF FUNK'S 90 DAY AND CHAMPION WHITE PEARL ON TREATED AND ON UNTREATED LAND: 1915
(Bushels per acre)

Plot No.	Treatment	Newton field		Oblong field	
		Funk's 90 Day	Champion White Pearl	Funk's 90 Day	Champion White Pearl
101	0[1]	4.0	4.8	23.2	39.8
102	M	5.2	4.0	40.4	50.2
103	ML	13.2	18.0	50.6	53.0
104	MLP	15.2	20.0	43.4	59.6
105	0	8.4	9.6	20.8	36.0
106	R	5.6	10.0	24.4	37.4
107	RL	11.2	20.0	38.0	46.6
108	RLP	16.0	21.2	46.4	52.4
109	RLPK	16.8	20.0	54.4	58.6
110	0	1.6	4.0	16.0	30.6

[1]0=no treatment; L=limestone; K=potassium; M=farm manure; P=phosphorus; R=crop residues.

long, Champion White Pearl produced decidedly higher yields than Funk's 90 Day on all plots, both treated and untreated.

Champion White Pearl, Perrine's White Pearl, and Easterly's White varieties have been grown in southern Illinois until they have become well adapted to conditions obtaining there. Varieties such as Reid's Yellow Dent and Funk's 90 Day, which have been grown under the more favorable soil conditions of central Illinois, cannot compete with adapted varieties on the poor land of southern Illinois. But

where the soil is enriched, they produce, in favorable seasons, larger yields than the varieties commonly found in that section, as may readily be seen from Table 8.

A BRIEF HISTORY OF CERTAIN VARIETIES OF CORN

It is impossible to give a detailed account of the origin and development of all the varieties of corn mentioned in this bulletin, because, in many cases, nothing is known concerning the source of the different types.

Boone County White was originated by Mr. James Riley of Indiana in 1876. The parent type was known as White Mastodon, which was a coarse, late-maturing variety. In 1882 some of the seed was brought to Champaign county by Mr. O. C. Black. The variety matures in 115 to 125 days.

Champion White Pearl originated thru the crossing and recrossing of several varieties of dent corn from different states. Mr. James C. Suffern of Piatt county, Illinois, states that he used for the cross Hickory King, Ohio White Dent, Wisconsin White Dent, White Normandy (from Missouri), and about ten other varieties from Iowa, Indiana, Pennsylvania, New Jersey, Kansas, Kentucky, and Nebraska. The crossing processes were followed by about twenty years of continuous systematic selection. This variety matures in about 110 to 115 days.

Chinese Poor Land was brought to this country from China about 1898. It is a white variety, and matures in 100 to 115 days. The seed was furnished the Station by Mr. George Olendorph of Marion county, Illinois.

Easterly's White was developed from Boone County White. The original seed was secured from Mr. A. P. Grout in 1901. Mr. H. G. Easterly of Jackson county, Illinois, changed the name to Easterly's White. Ordinarily the variety develops fully in 115 to 125 days.

Funk's 90 Day was originated from one-half bushel of a variety known as Little Early Murdock. Mr. E. D. Funk purchased the seed from the University of Illinois in 1892 and began to improve it in 1901. It is a yellow variety which matures in about 90 to 100 days.

Golden Eagle was originated by Mr. H. B. Perry of Stark county, Illinois, by selecting seed from the so-called Mason County Yellow corn, beginning in 1871. It matures in about 110 days from the time of planting.

Golden Glow was produced by crossing Wisconsin No. 8 and a variety of yellow corn known as North Star. Professor R. A. Moore of the University of Wisconsin states that the result of this cross was perfected by putting it thru an ear-to-row test for about ten years. In Wisconsin this is one of the most widely known varieties and is one of the earliest maturing in that section.

Golden King was first selected thirty years ago from a variety known as Hamm corn. Mr. W. L. Mills of Putnam county, Illinois, purchased seed of this variety about twenty years ago and produced a cross with Leaming. For about ten years Mr. Mills has grown this hybrid corn with success. From 110 to 125 days are necessary for its full development.

Golden Surprise is the result of a hybrid which was originated in 1890 by Mr. Simon Bell and son, of Perry county, Ohio. The variety was produced by crossing an unknown type and a small-eared, amber-colored corn known as Shoepeg. This variety matures in about 100 days.

Griffith's Early Dent was produced by Mr. H. K. Smith, after whom it was named Smith's Yellow Dent. It is the result of a cross of Pride of the North and a variety known as Coe, which was brought from Ohio about sixty years ago. The variety produced by the cross mentioned matures in about 95 to 100 days, and is a yellow corn, larger than Pride of the North. After Mr. Smith's death, Mr. W. G. Griffith took charge of the improvement of this variety and changed the name to Griffith's Early Dent.

Leaming is said to be the oldest improved variety of corn. It was originated by Mr. J. S. Leaming of Wilmington, Ohio, in 1826. At that time Mr. Leaming began selecting seed from the ordinary yellow corn grown on the Little Miami bottoms, Hamilton county, Ohio, and selected toward a standard type for fifty-six years, after which the work was continued by his son, J. S. Leaming, Jr. This is a yellow corn which matures in about 110 days.

Murdock's Yellow Dent is a favorite early corn for southern Wisconsin, where, it is said, this variety has been grown longer than any other. It has been improved by the University of Wisconsin and by farmers of the state until it has reached a rather high degree of productivity.

Perrine's White Pearl has been grown for about twelve years by Mr. G. D. Perrine and sons of Marion county, Illinois. The original seed was purchased from a dealer in Coles county. Usually this variety matures in 115 to 125 days.

Reid's Yellow Dent was originated by Mr. Robert Reid, who, in 1846, brought a rather late maturing variety known as Gordon Hopkins corn, from Brown county, Ohio, to Tazewell county, Illinois. This corn was reddish colored, and was widely grown in the vicinity in which Mr. Reid lived. The seed was planted near Delavan, Illinois, late in the spring of 1846, and a fair yield of immature corn was harvested. From this, seed was selected for the following crop, but on account of immaturity a poor stand resulted. In the spring of 1847, missing hills were replanted with seed of a little yellow corn, a rather early-maturing variety grown quite generally in Tazewell county at that time. By this replanting it is supposed that a cross

was produced between the two varieties. Seed from this crop furnished the foundation for Reid's Yellow Dent, which has been in the hands of members of the Reid family until very recently. It matures in about 110 to 120 days.

Riley's Favorite was originated in 1883 by Mr. James Riley of Indiana, who developed Boone County White. It is the result of a cross between Golden Yellow, a large, late corn, and Pride of the North, a small, early corn. As a rule, 100 to 110 days are required for maturing.

Silvermine, later known as Iowa Silvermine, was originated by Mr. J. H. Beagley of Ford county, Illinois, from seed selected from a prize-winning exhibit of white corn at the Ford County Farmers' Institute in 1890. After sufficient corn had been grown to plant a twenty-acre field, the crop was sold to the Iowa Seed Company, who named the variety Iowa Silvermine, and sold large quantities of the seed to Illinois farmers. This variety has been developed by selection, and no crossing or mixing of varieties has ocurred. It is a white corn, and requires 100 to 110 days for maturing.

Strout's Red was developed from a variety called Molasses. Originally the color ranged from deep red to almost black. Some ears were dingy white. Mr. E. J. Strout, of LaSalle county, Illinois, has given this variety special attention during the last sixteen years. It matures in 100 to 105 days.

Sutton's Favorite was introduced into Marion county from Cass county, Illinois, by Mr. T. N. Sutton, in about 1875. The variety has not been materially changed from the time of its early introduction. Details of the early history of this corn are very meager, but the parent strain seems to have been known as Faulkner. It is a white corn and matures in about 115 to 125 days.

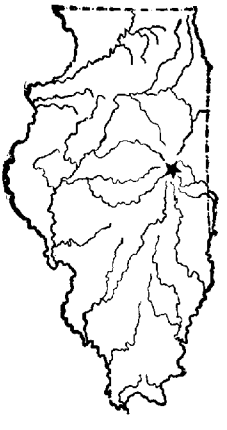
Western Plowman and Will County Favorite were originated about twenty years ago by Mr. William Green and Mr. William Webb. These men were seeking an early-maturing corn which would be suitable for conditions in Will county, Illinois. Mr. Green was at that time growing a rather coarse yellow corn which he called Western Plowman. This strain was late, but it was a heavy yielder when the seasons were long enough for full maturing. Mr. Webb was growing a variety known as Golden Yellow Dent. This was an attractive early corn, but the ears were very small. Western Plowman, Golden Yellow Dent, and a variety known as Edmond's were mixed, and grown so that crossing would result, and from the harvest of this triple combination Mr. Green and Mr. Webb each took a half-bushel of seed. The former assigned to his strain the name of Western Plowman, and the latter, Will County Favorite. Both men afterwards continued to select and breed the corn until the strains were properly developed. Both varieties are yellow and mature fairly early.

UNIVERSITY OF ILLINOIS
Agricultural Experiment Station

BULLETIN No. 192

FEEDING PURE-BRED DRAFT FILLIES

By J. L. EDMONDS



URBANA, ILLINOIS, DECEMBER, 1916

SUMMARY OF BULLETIN NO. 192

OBJECT.—To determine the efficiency of alfalfa hay, corn, and oats in growing pure-bred draft fillies to two years of age.

PLAN.—Ten pure-bred Percheron fillies were fed from weanlings to two years of age. The experiment, covering two winter and one summer feeding periods, began December 8, 1914, and ended when the fillies were turned on pasture May 8, 1916. Oats and corn were fed, one-half of each by weight, with alfalfa hay as the sole roughage. The pasture was a blue-grass sod, containing a slight mixture of other grasses. Page 427

RESULTS.—The trial seemed to indicate that a liberal portion of well-cured legume hay should be the foundation for feeding young, growing horses. Along with this roughage, enough grain should be fed to produce the desired growth. In this experiment it seemed necessary, unless the fillies received a set-back in growth, to feed some grain thruout the pasture season. Pages 429, 434

Alfalfa hay fed with corn and oats gave results of a character which indicates that there is little or no need of feeding purchased mill feeds to growing horses when alfalfa can be grown on the farm. When alfalfa hay is the roughage used, a considerable proportion of the grain ration may safely be corn. In this experiment the proportion was one-half by weight. Page 436

The average total feed consumed per head during the experiment was 45.35 bushels of corn, 79.36 bushels of oats, 2.58 tons of alfalfa hay, and four-fifths of an acre of good grass. The average total gain in weight per individual was 690.5 pounds, and in height, 7.96 inches. The average daily gain was 1½ pounds. Pages 434, 437

During the first winter an average of 5.674 pounds of grain and 4.266 pounds of hay was required per pound of gain. The second winter feeding period required an average of 9.228 pounds of grain and 12.99 pounds of hay per pound of gain. Pages 437-438

The average weight of the lot at twelve months was 1,112 pounds; at twenty-four months, 1,548 pounds. The average weight of eight head, the two youngest fillies being excluded, at corresponding ages, was 1,128 pounds and 1,578 pounds respectively. The growthiest filly weighed 1,260 pounds at twelve months and 1,775 pounds at twenty-four months. Pages 437, 438

COST.—The three sets of prices used in figuring the feed cost show $86.85, $105.50, and $108.49, respectively, as the value of the feed consumed by the ten head. Pages 439-440

FEEDING PURE-BRED DRAFT FILLIES

By J. L. EDMONDS, Assistant Chief in Horse Husbandry

OBJECT OF THE EXPERIMENT

From weaning time to two years of age is generally recognized as a critical period in the development of draft horses. Both grades and pure-breds are frequently not well enough grown out to permit anywhere near the development of their inherent possibilities. The object of the experiment reported in this bulletin was to determine the efficiency of alfalfa hay, corn, and oats in growing pure-bred weanling draft fillies to two years of age.

PLAN

Ten pure-bred Percheron filly foals dropped in the spring and summer of 1914 were used in the trial. Four of the number were foaled by mares owned by the Experiment Station; the rest were purchased from Illinois breeders. The experiment began December 8, 1914. The fillies were carried thru two winters and one summer, the trial being completed May 8, 1916.

Feed

The grain feeds used were oats and corn, one-half of each by weight. Grain was fed three times a day except when the fillies were on grass; then it was fed twice a day. During the first winter the oats and corn were ground, and after that whole oats and shelled corn were fed. Shelled corn was used instead of ear corn because it insured each individual a somewhat better chance of obtaining her share. Alfalfa hay grown on the farm of the Animal Husbandry Department was the sole roughage used. Hay was fed twice a day except when the fillies were on pasture, during a part of which time no hay was fed; after the pasture became short, hay was fed once a day. More grain would have been eaten than was fed; with the alfalfa hay, however, the aim thruout the trial was to feed as much of it as would be thoroly cleaned up. This method of feeding resulted in no feed being wasted and did away with any necessity of weighing back refused feed. Alfalfa, corn, and oats were the feeds selected, since the aim was to secure good results with farm feeds rather than purchased mill feeds, and these three are widely available on corn-belt farms. The ten head were fed in one lot from racks and troughs built along the sides of the loose boxes used for shelter.

Samples of the grain and hay were saved regularly at each feeding time. The results of the analyses of these samples which were made by the division of animal nutrition of this station are given in Table A, page 441.

The pasture, eight acres in area, was heavy blue grass with a slight mixture of timothy, orchard grass, medium red, and white clover. The fillies ran on pasture during pasture season only; at other times they had access to a half-acre cinder lot.

Salt was regularly added to the grain feed.

Well water was supplied from a tank so located that one-half of it was available in each box stall.

SHELTER

The fillies' shelter consisted of two 16-by-20-foot box stalls. Doors 8 feet wide opened into a small cinder lot which connected the boxes with the pasture and the half-acre cinder-covered exercise lot. The box-stall doors were closed only during a very few of the most stormy nights in winter. Altho at practically all other times the fillies had their choice of being outdoors or in, they seemed to prefer the open, except at feeding times and during the heat of the day in summer. This method of stabling insured sufficient protection without any undue restriction of opportunity for exercise, which must accompany good feeding if the best all-around results are to be obtained. Canvas "flappers" nailed to the over-head joists assisted in keeping the flies off the backs of the fillies. An application of coal-tar disinfectant to the lower part of the canvas prevented it from being chewed or torn down.

BEDDING

Shavings were used for bedding. Straw bedding, while most desirable in ordinary practice, would have prevented an accurate feed record because a varying portion of it would have been eaten. Fresh bedding was added as needed; the box stalls were cleaned directly into the manure wagons once or twice a month.

GROOMING

The fillies were tied up daily and given a hurried grooming with a dandy-brush. Once a month, or oftener if necessary, their feet were gone over carefully and leveled with a hoof rasp.

DESCRIPTION OF THE FILLIES

Table 1 describes the pure-bred Percheron fillies used in this experiment. The group pictures, taken late in the winter, show quite clearly the sort of fillies which made up the lot. Two of the ten head

Isabel and Dorethy, were at some disadvantage because they were younger than the rest of the lot. All individuals, as their weights would indicate, had received good treatment previous to the time of the experiment.

TABLE 1.—DESCRIPTION OF FILLIES AT BEGINNING OF EXPERIMENT, DECEMBER 8, 1914

Name	Stud-book No.	Breeder	Color	Date foaled, 1914	Age	Weight	Height	
					days	*lbs.*	*hands*	*inches*
Blue Bell..	110669	University of Illinois...	Gray, star, stripe...	May 13	209	810	13	2¼
Dorethy...	110194	Geo. Frerichs and Sons....	Black, white on right hind foot.....	June 2.	189	725	13	1½
Dottie Sloan...	106156	Geo. Frerichs and Sons....	Black, star	May 15.	207	930	13	2
Eleanor...	110668	University of Illinois...	Gray, star	Apr. 25	227	970	14	½
Isabel.....	110670	University of Illinois...	Gray, elongated star.....	July 2.	159	685	13	1¼
Karol.....	110836	Imported in dam	Gray.....	Apr. 12	240	880	13	3¾
Madame...	109992	A. L. Robison and Sons....	Black, tan markings..	Apr. 23	229	830	13	3½
Midinette..	109993	A. L. Robison and Sons....	Gray.....	Apr. 28	224	810	13	¾
Primrose..	106240	Geo. Frerichs and Sons....	Black, star.	May 25.	197	775	13	1¾
Miss Yoke.	111136	G. W. Weyhrich	Gray.....	Mar. 21	262	815	13	2¼
Average of 10 head.....					214.3	823	13	2⅛

DISCUSSION OF RESULTS

Table 2 shows the average individual consumption of feed for the different periods of the experiment, and Tables 3 and 4 the weights, heights, and gains of the fillies during the same periods.

During the first period, the fillies were allowed as much grain and hay as they would readily consume. This, tho it resulted in good gains, did not seem to be a profitable nor an entirely safe procedure because of the high grain consumption. Accordingly, the grain ration was gradually restricted until it was reduced to an amount which insured the consumption of a pound or more of hay per day to the hundredweight of filly. Experience here would seem to indicate that a liberal portion of well-cured legume hay should be the foundation for feeding young, growing horses. In addition to the legume rough-

FIG. 1.—THE LOT AS YEARLINGS

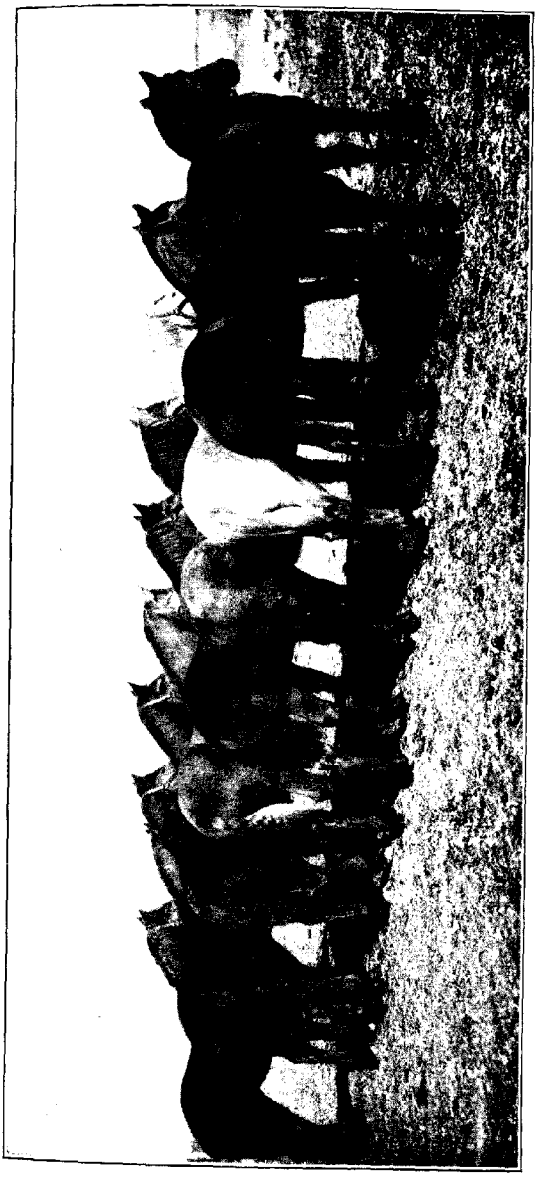


FIG. 2.—THE LOT AS YEARLINGS

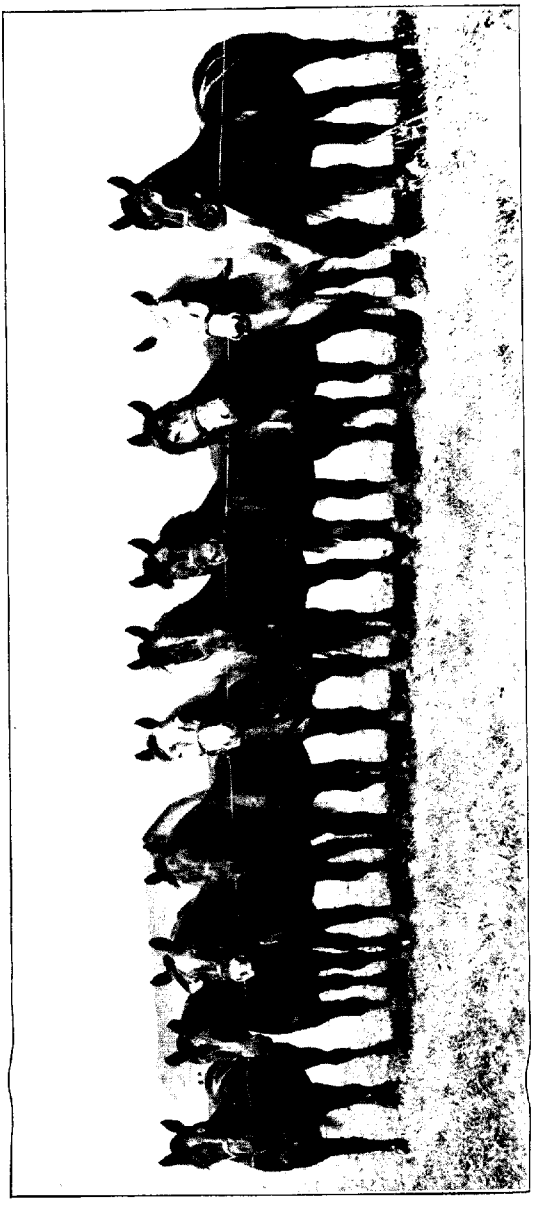


FIG. 3.—THE LOT AS TWO-YEAR-OLDS

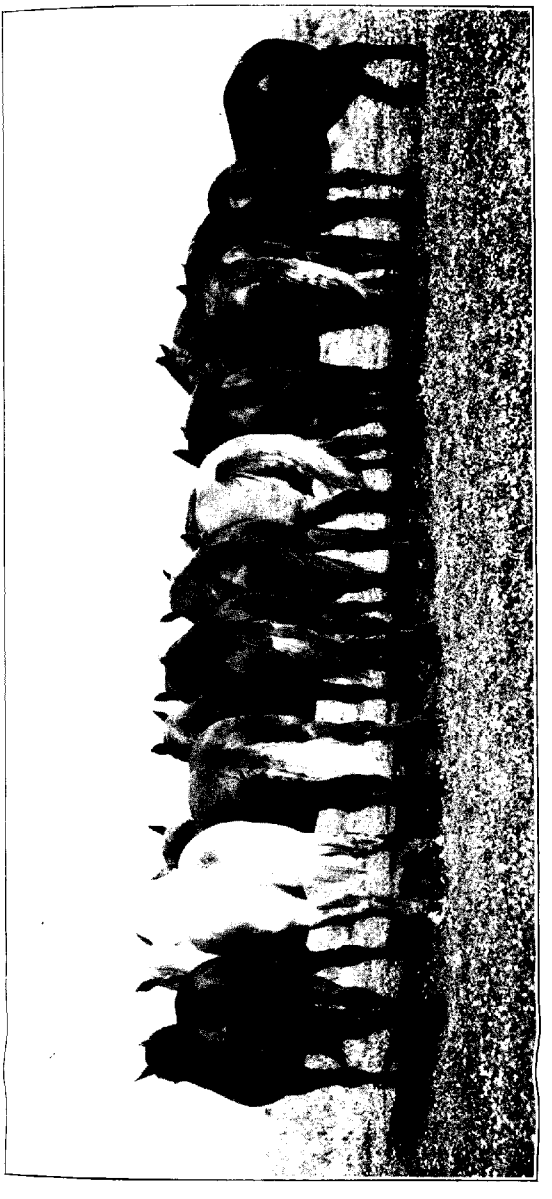


FIG. 4.—THE LOT AS TWO-YEAR-OLDS

age, enough grain should be fed to produce good growth. The figures indicate that as the individual becomes older it is possible and desirable to decrease the proportion of grain and increase the proportion of hay, and still obtain excellent gains.

A grain feed of approximately one-half pound per day to the hundredweight of filly seems to be enough to produce proper development on pasture. Altho the pasture used in this experiment was about as good as can ordinarily be found, the eight acres were not quite enough to furnish an abundance of grass. This made it necessary during three of the periods on pasture to feed an amount of hay daily which equaled the amount of grain fed at that time.

TABLE 2.—FEED CONSUMED BY PERIODS

(Grain[1] = Corn ½ and Oats ½: Hay = Alfalfa Hay[2] and Pasture[3])
(Expressed in pounds)

Period: 28 days	Average daily ration per head		Average total feed per head per period		Average daily feed per day per cwt. of animal		Average amount of feed required per pound of gain	
	Grain	Hay	Grain	Hay	Grain	Hay	Grain	Hay
Dec. 8, 1914–Jan. 4, 1915	13.72	4.97	384.2	139.2	1.607	.582	6.57	2.38
Jan. 5–Feb. 1..	10.96	4.93	307.0	138.0	1.224	.550	7.22	3.25
Feb. 2–Mch. 1..	10.79	8.94	302.0	250.2	1.124	.931	4.14	3.43
Mch. 2–Mch. 29..	10.54	10.31	295.2	288.6	1.036	1.013	6.49	6.34
Mch. 30–Apr. 26..	9.60	10.64	268.8	298.0	.902	1.000	5.38	5.96
Apr. 27–May 24..	9.88	6.68[4]	276.6	187.0	.880	.595	4.04	2.73
May 25–June 21..	6.10	.....	170.8	.....	.516	.....	4.02	.....
June 22–July 19..	6.20	.....	173.6	.....	.518	.....	.....[5]	.....
July 20–Aug. 16..	6.20	6.20	173.6	173.6	.511	.511	4.69	4.69
Aug. 17–Sept. 13..	6.20	6.20	173.6	173.6	.502	.502	16.53	16.53
Sept. 14–Oct. 11..	6.50	6.50	182.0	182.0	.522	.522	13.00	13.00
Oct. 12–Nov. 8..	10.51	15.46	294.4	432.8	.831	1.222	9.65	14.19
Nov. 9–Dec. 6..	10.83	18.14	303.2	508.0	.827	1.386	4.93	8.26
Dec. 7, 1915–Jan. 3, 1916	11.31	18.11	316.8	507.0	.832	1.332	15.09	24.14
Jan. 4–Jan. 31..	11.60	14.21	324.8	398.0	.839	1.029	12.99	15.92
Feb. 1–Feb. 28..	11.60	14.32	324.8	401.0	.824	1.017	10.83	13.37
Feb. 29–Mch. 27..	11.60	15.00	324.8	420.0	.805	1.041	9.28	12.00
Mch. 28–Apr. 24..	11.44	15.99	320.4	447.6	.771	1.077	7.63	10.66
Apr. 25–May 8 (*14 days*)	11.60	16.00	162.4	224.0	.769	1.061	13.53	18.66
Total time: Dec. 8, 1914, to May 8, 1916, 518 days...	9.805	9.978	5 079[6]	5 168.6 (2.5843T)	.811	.825	7.356	7.485

[1]Grain was ground during the first winter.
[2]No hay was fed from May 14 to July 19, 1915.
[3]On pasture from May 14 to October 11, 1915.
[4]For 17 days.
[5]The fillies lost in weight during the period June 22 to July 19, as may be seen from Tables 3 and 4.
[6]45.35 bushels of corn; 79.36 bushels of oats.

The amounts and kinds of feeds were well adapted to the needs of the fillies. An average daily gain of 1⅓ pounds, a total gain in weight of 690.5 pounds, and a total gain in height of almost 8 inches is entirely satisfactory. Several factors—distemper, drying up of pasture in late summer, and flies—were responsible for the comparative irregularity of the increases in weight. Shortly after the trial started the fillies all had distemper, several of them quite severely, but at all other times they were in thrifty condition, and made an excellent growth of bone and muscle. At no time during the trial did they carry more condition than was desirable from the standpoint of growth. The actual growth in height was in all probability not as uneven as the table shows it to be. At the beginning of the experiment it was somewhat of a proposition to get the weanlings to stand properly while the standard was applied, and during the winter months the cinders in the exercise lot kept the feet of the fillies considerably shorter than they were when on grass.

TABLE 3.—INDIVIDUAL GAINS IN WEIGHT BY PERIODS

(Expressed in pounds)

Period: 28 days	Blue Bell	Dorothy	Dottie Sloan	Eleanor	Isabel	Karol	Madame	Midinette	Primrose	Miss Yoke
Initial weight Dec. 8, 1914.....	810	725	930	970	685	880	830	810	775	815
Dec. 8–Jan. 4....	30	70	75	55	40	30	90	60	65	70
Jan. 5–Feb. 1....	60	50	50	45	40	10	20	35	40	75
Feb. 2–Mch. 1....	65	60	40	95	100	80	85	75	65	65
Mch. 2–Mch. 29....	50	45	45	45	5	60	65	40	55	45
Mch. 30–Apr. 26....	75	45	35	65	40	65	55	5	45	70
Apr. 27–May 24....	90	50	55	80	60	50	70	80	75	75
May 25–June 21....	10	35	60	45	40	75	40	30	50	40
June 22–July 19....	0	−25	−40	−15	25	−5	−15	10	−15	−5
July 20–Aug. 16....	40	40	35	25	30	35	50	55	50	10
Aug. 17–Sept. 13....	5	−10	15	10	15	10	35	0	20	5
Sept. 14–Oct. 11....	25	−15	−10	−15	20	25	25	30	40	15
Oct. 12–Nov. 8....	35	60	45	80	55	20	5	−20	−10	35
Nov. 9–Dec. 6....	70	55	85	40	55	65	50	75	70	50
Total gain: Dec. 8, 1914–Dec. 6, 1915..	555	460	490	555	525	520	575	475	550	550
Dec. 7–Jan. 3..	20	20	20	55	10	−5	35	−5	30	30
Jan. 4–Jan. 31....	20	25	35	35	20	20	15	20	35	25
Feb. 1–Feb. 28....	15	35	35	0	35	45	25	30	30	50
Feb. 29–Mch. 27....	30	40	45	90	−5	50	25	20	15	40
Mch. 28–Apr. 24....	50	45	50	45	45	40	40	30	35	40
Apr. 25–May 8....	−10	15	20	25	25	−20	20	25	15	5
Total gain: Dec. 7, 1915–May 8, 1916..	125	180	205	250	130	130	160	120	160	190
Total gain: Dec. 8, 1914–May 8, 1916..	680	640	695	805	655	650	735	595	710	740
Final weight.....	1 490	1 365	1 625	1 775	1 340	1 530	1 565	1 405	1 485	1 555

[1] 14 days.

Alfalfa hay fed with corn and oats gave results of a character which indicates that there is little or no need of feeding bran or other purchased mill feeds when a good quality of alfalfa hay can be grown on the farm. Because of its high protein and mineral content, of calcium especially, alfalfa hay is well suited to grow the heavy muscles and large, strong bones which are necessary for the real drafter. A greener, leafier quality of hay was fed to these fillies than usually gives best results when fed to hard-worked horses; and it was not found necessary in the case of these growing fillies, as with mature animals, to limit the amount of alfalfa hay fed. Furthermore, when alfalfa hay is the roughage used, a considerable proportion of the grain ration, in this trial one-half by weight, may be corn, the grain grown in greatest quantity in the Middle West.

It seems quite clear from this and other similar trials that in addition to liberal grain feeding, which is admittedly necessary and important for growing drafters, the development of size and quality of bone is also intimately connected with the grazing on pasture of nutritious grasses and clovers and the feeding of good legume rough-

TABLE 4.—WEIGHTS, HEIGHTS, AND GAINS OF ALL THE FILLIES BY PERIODS

Period: 28 days	Average weight per head[1]	Average daily gain in weight per head	Average total gain in weight per head	Average height per head[2]		Average total gain in height per head
	lbs.	*lbs.*	*lbs.*	*hands*	*inches*	*inches*
Dec. 8, 1914–Jan. 4, 1915	854.1	2.09	58.5	13	2.35	1.20
Jan. 5–Feb. 1	895.8	1.52	42.5	13	3.55	.80
Feb. 2–Mch. 1	959.8	2.61	73.0	14	.35	.49
Mch. 2–Mch. 29	1 017.4	1.63	45.5	14	.84	.76
Mch. 30–Apr. 26	1 064.8	1.79	50.0	14	1.60	.40
Apr. 27–May 24	1 122.2	2.45	68.5	14	2.00	.63
May 25–June 21	1 182.8	1.52	42.5	14	2.63	.67
June 22–July 19	1 196.4	-.30	-8.5	14	3.30	.15
July 20–Aug. 16	1 213.7	1.32	37.0	14	3.45	.03
Aug. 17–Sept. 13	1 234.6	.38	10.5	14	3.48	.47
Sept. 14–Oct. 11	1 244.7	.50	14.0	14	3.95	.50
Oct. 12–Nov. 8	1 264.9	1.09	30.5	15	.45	.04
Nov. 9–Dec. 6	1 309.4	2.20	61.5	15	.49	.66
Dec. 7, 1915–Jan. 3, 1916	1 358.8	.75	21.0	15	1.15	.34
Jan. 4–Jan. 31	1 382.0	.89	25.0	15	1.49	.36
Feb. 1–Feb. 28	1 408.1	1.07	30.0	15	1.85	.19
Feb. 29–Mch. 27	1 440.7	1.25	35.0	15	2.04	.23
Mch. 28–Apr. 24	1 484.1	1.50	42.0	15	2.27	.04
[5]Apr. 25–May 8	1 507.7[2]	.86	12.0	15	2.73[4]	...
Total time: Dec. 8, 1914, to May 8, 1916	.....	1.333	690.5	..	....	7.96

[1]Calculated from weekly weights. [2]Final average weight, 1513.5 pounds. [3]At beginning of each period. [4]Final height, 15 hands 2.31 inches. [5]14 days.

ages during seasons when such pasture is not available. In this test desirable growth of frame was made on pasture which was not fully indicated by the weights of the fillies. On most farms it would be of advantage to use more pasture than was available in this trial, and in the winter to feed some of the coarse roughages, such as corn fodder, oat straw, or sorghum along with alfalfa.

When, as the experiment shows, an average of 45.35 bushels of corn, 79.36 bushels of oats, 2.58 tons of alfalfa, and four-fifths of an acre of good pasture will keep individuals of the kind used in this experiment in thrifty and salable condition from the fall of the year in which they are foaled up to the time they are two years of age, it would seem worth while to grow out well-bred young drafters properly, and thus obtain the size and finish which experience has shown to be necessary for the greatest remuneration.

FEED CONSUMED AND GAINS BY SEASONS

Table 5, giving the feed consumption and the gains by seasons, shows that the largest gains, in proportion to feed consumed, were made during the first winter, when an average of 5.674 pounds of grain and 4.266 pounds of hay were required per pound gain. The second winter feeding period required an average of 9.228 pounds of grain and 12.990 pounds of hay, the average grain requirement per pound of gain being at this time almost twice as much and the hay requirement slightly over three times as great as it was during the first winter.

It is of particular advantage to have pure-breds well grown at two years of age, because well-grown individuals of both sexes are in good demand at that age. A study of these figures would seem to show the fallacy of attempting to make good draft horses by roughing weanlings thru the winter with stunted yearlings as a result. Continued liberal feeding thru the summer and the succeeding winter made big, growthy, two-year-old fillies that were much nearer maturity than if they had been forced to subsist on a ration too limited in either or both the quantity and the quality of the nutrients which it contained. The group pictures of the two-year-olds will prove interesting in this connection.

WEIGHTS AND HEIGHTS OF THE FILLIES AT ONE AND TWO YEARS OF AGE

The weights and heights recorded in Table 6 were taken on the days the fillies were one and two years of age. Dorothy and Isabel, foaled in June and July, are not included in the average for the eight head, because in addition to being foaled late they were hardly drafty enough to be compared with the others. A comparison of the illustrations of the individuals and the data regarding their respective

TABLE 5.—FEED CONSUMED AND GAINS BY SEASONS

Time	Average daily ration per head		Average total feed per head		Average daily feed per day per cwt. of animal		Average amount of feed required per pound gain		Average daily gain in weight per head	Average total gain in weight per head	Average total gain in height per head
	Grain	Hay	Grain	Hay	Grain	Hay	Grain	Hay			
	lbs.	*lbs.*	*lbs.* (*bu.*)	*lbs.* (*tons*)	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*inches*
First winter: Dec. 8–May 13, 157 days	11.023	8.287	1 730.60 (C 15.45) (O 27.04)	1 301.00 (.65)	1.1356	.8540	5.674	4.266	1.943	305.0	4.17
Summer: May 14–Oct. 11, 151 days	6.469	3.505	976.80 (C 8.72) (O 15.26)	529.20 (.26)	.5360	.2905	7.602	4.118	.851	128.5	1.93
Second winter: Oct. 12–May 8, 210 days	11.293	15.897	2 371.60 (C 21.17) (O 37.06)	3 338.40 (1.67)	.7880	1.1090	9.228	12.990	1.224	257.0	1.86
One year: Dec. 8–Dec. 6	9.079	7.613	3 305.00 (C 29.51) (O 51.64)	2 771.00 (1.39)	.8120	.6810	6.289	5.273	1.444	525.5	6.80
Five months: Dec. 7–May 8	11.519	15.569	1 774.00 (C 15.84) (O 27.72)	2 397.60 (1.20)	.8090	1.0940	10.750	14.530	1.071	165.0	1.16
Total: One year and 5 months, Dec. 8, 1914, to May 8, 1916	9.805	9.978	5 079.00 (C 45.35) (O 79.36)	5 168.60 (2.58)	.8110	.8250	7.356	7.485	1.333	690.5	7.96

gains as given in Tables 3 and 6 will prove of interest. The heaviest filly, Eleanor, weighing 1,260 pounds at one year and 1,775 pounds at two years of age, was one of the "top" fillies of the lot.

TABLE 6.—WEIGHTS AND HEIGHTS OF THE FILLIES AT ONE AND TWO YEARS OF AGE

Name	Weight at one year	Weight at two years	One year's gain in weight	Height at one year		Height at two years		One year's gain in height
	lbs.	*lbs.*	*lbs.*	*hands*	*inches*	*hands*	*inches*	*inches*
Blue Bell	1 120	1 550	430	14	2¼	15	3	4¾
Dorothy	1 060	1 425	365	14	1¾	15	2	4¼
Dottie Sloan	1 200	1 690	490	14	2½	15	2	3½
Eleanor	1 260	1 775	515	15	¼	16	⅛	3⅞
Isabel	1 035	1 430	395	14	2¾	16	½	5¾
Karol	1 095	1 570	475	14	2¾	15	3⅜	4⅝
Madame	1 135	1 545	410	14	2¾	15	3½	4¾
Midinette	1 035	1 435	400	14	¼	15	1	4¾
Primrose	1 120	1 555	435	14	1½	15	2	4½
Miss Yoke	1 060	1 505	445	14	1½	15	2¼	4¾
Average for 10 head	1 112	1 548	436	14	2¼	15	2¾	4½
Average for 8 head[1]	1 128	1 578	450	14	2¼	15	2⅔	4⅝

[1]The late-foaled fillies, Dorothy and Isabel, are excluded in the average for the eight head.

COST OF FEEDS

In Table 7 are presented three sets of figures showing the costs of feed for the different seasons and the total for the one year and five months during which the trial continued. A and B prices are those used in figuring the cost of feed in several other feeding trials conducted by the Experiment Station. C prices represent the actual prices paid for the grain used during the second winter as delivered at the barn. The alfalfa hay which was fed at that time had a value of not more than $11 in the mow. Using these latter figures, the cost in cents per pound of gain was 7.98 for the first winter, 16.04 for the summer, and 16.31 for the second winter. The average total cost of feed per head with C prices was $56.07 for the year and $86.88 for the year and five months. Comparison of the pictures of the weanlings with those of the two-year-olds will show pretty well the development which was made. It is believed that on many farms where pure-breds are raised, similar results could be had at less, rather than more expense for feed. A modification of the ration fed during the trial, as suggested in discussing Table 2, would probably be the means of accomplishing this.

TABLE 7.—COST OF FEEDS

Time		Average total cost of feed per head			Av. total cost of feed per head per day in *cents*			Average cost of feed per pound gain in *cents*		
		A	B	C	A	B	C	A	B	C
First winter: Dec. 8–May 13, 157 days	Grain	$19.47	$20.86	$17.19						
	Hay	10.41	9.11	7.16						
	Total	$29.88	$29.97	$24.35	19.03	19.09	15.51	9.80	9.83	7.98
Summer: May 14–Oct. 11, 151 days (⅘ acre of pasture per head)	Grain	$10.99	$11.77	$ 9.70						
	Hay	4.23	3.70	2.91						
	Pasture	10.00	8.10	8.00						
	Total	$25.22	$23.57	$20.61	16.70	15.61	13.65	19.63	18.34	16.04
Second winter: Oct. 12–May 8, 210 days	Grain	$26.68	$28.59	$23.56						
	Hay	26.71	23.37	18.36						
	Total	$53.39	$51.96	$41.92	25.42	24.74	19.96	20.77	20.22	16.31
One year: Dec. 8–Dec. 6	Grain	$ 37.18	$ 39.84	$32.83						
	Hay	22.17	19.40	15.24						
	Pasture	10.00	8.10	8.00						
	Total	$ 69.35	$ 67.34	$56.07	19.05	18.50	15.40	13.20	12.81	10.67
Five months: Dec. 7–May 8, 154 days	Grain	$ 19.96	$ 21.38	$17.62						
	Hay	19.18	16.78	13.19						
	Total	$ 39.14	$ 38.16	$30.81	25.42	24.78	20.00	23.72	23.13	18.67
One year and five months: Dec. 8–May 8, 518 days	Grain	$ 57.14	$ 61.22	$50.45						
	Hay	41.35	36.18	28.43						
	Pasture	10.00	8.10	8.00						
	Total	$108.49	$105.50	$86.88	20.94	20.37	16.77	15.71	15.28	12.58

A = Alfalfa, $16 per ton; corn, 56 cents per bushel; oats, 40 cents per bushel; pasture, $2 per calendar month per head.

B = Alfalfa, $14 per ton; corn, 65 cents per bushel; oats, 40 cents per bushel; pasture, $1.50 per 28 days per head.

C = Alfalfa, $11 per ton; corn, 50 cents per bushel; oats, 35 cents per bushel; pasture, $10 per acre—8 acres.

COMPOSITION OF THE FEEDS

TABLE A.—CHEMICAL COMPOSITION OF THE COMPOSITE SAMPLES OF THE FEEDS CONSUMED BY THE FILLIES

(Results expressed in percent of the fresh substance)

Analyzed by H. S. Grindley and C. I. Newlin

Kind of feed	Dry matter	Nitrogen-free extract	Crude protein (Nx6.25)	Ether extract	Crude ash	Crude fiber
Dec. 14, 1914, to Mar. 7, 1915:						
Ground corn	88.98	73.43	9.24	3.03	1.30	1.99
Ground oats	93.56	61.93	13.31	5.26	3.34	9.72
Alfalfa hay	92.86	38.89	14.75	1.82	6.50	30.90
Mar. 8 to May 30, 1915:						
Ground corn	88.91	72.76	9.46	3.28	1.38	2.03
Ground oats	92.01	59.32	13.67	5.04	3.63	10.35
Alfalfa hay	91.64	41.36	13.96	2.03	5.82	28.47
May 31 to June 27, 1915:						
Shelled corn	88.52	71.09	9.63	4.33	1.35	2.13
Oats	91.62	56.43	15.04	5.47	3.71	10.97
June 28 to Aug. 22, 1915:						
Shelled corn	88.66	71.92	9.20	4.10	1.31	2.12
Oats	91.31	56.43	15.04	5.47	3.71	10.97
Aug. 23 to Oct. 17, 1915:						
Shelled corn	89.11	71.94	9.52	4.25	1.32	2.09
Oats	92.16	59.00	13.27	5.42	3.78	10.68
Alfalfa hay	91.36	38.85	14.87	2.10	6.53	29.01
Oct. 18 to Dec. 12, 1915:						
Shelled corn	86.96	69.99	9.45	4.23	1.22	2.07
Oats	89.72	60.21	10.45	5.23	3.31	10.43
Alfalfa hay	89.18	35.17	15.61	1.63	7.34	29.43
Dec. 13, 1915, to Feb. 6, 1916:						
Shelled corn	87.57	70.89	9.19	3.37	1.93	2.18
Oats	88.86	59.41	10.46	5.51	3.28	10.20
Alfalfa hay	90.07	34.84	16.26	2.07	6.62	30.28
Feb. 7 to April 30, 1916:						
Shelled corn	85.87	70.25	9.34	2.97	1.30	2.02
Oats	90.27	60.34	10.56	5.82	3.34	10.21
Alfalfa hay	91.37	38.99	15.21	2.14	6.25	28.77

FIG. 5.—BLUE BELL AS A TWO-YEAR-OLD

FIG. 6.—DOROTHY AS A TWO-YEAR-OLD

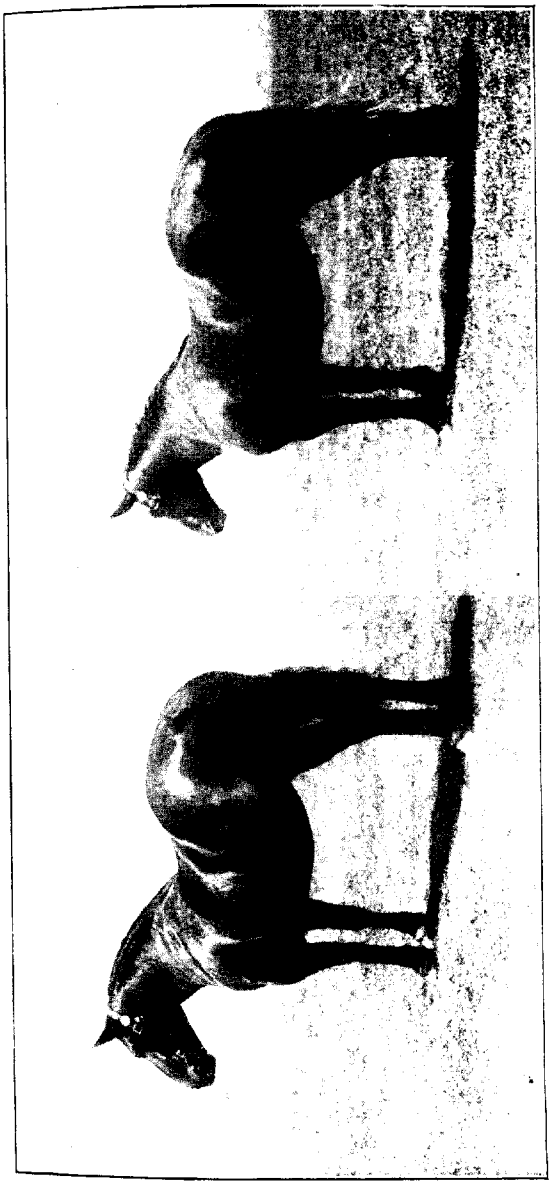


FIG. 7.—DOTTIE SLOAN AS A TWO-YEAR-OLD

FIG. 8.—ELEANOR AS A TWO-YEAR-OLD

FIG. 9.—ISABEL AS A TWO-YEAR-OLD

FIG. 10.—KAROL AS A TWO-YEAR-OLD

FIG. 11.—MADAME AS A TWO-YEAR-OLD

FIG. 12.—MIDINETTE AS A TWO-YEAR-OLD

FIG. 13.—PRIMROSE AS A TWO-YEAR-OLD

FIG. 14.—MISS YOKE AS A TWO-YEAR-OLD

FIG. 15.—ON PASTURE AT CLOSE OF TRIAL

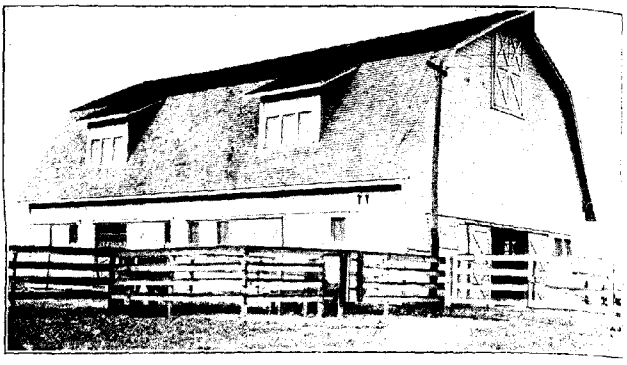


FIG. 16.—BROOD MARE BARN WHICH SHELTERED THE LOT

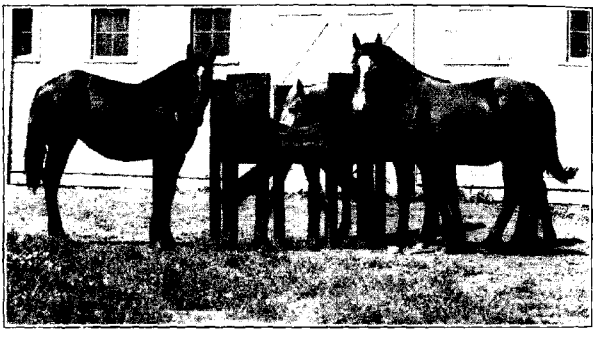


FIG. 17.—TUMBLER AND FILLIES

FIG. 18.—TUMBLER USED FOR FEEDING GRAIN IN PASTURE

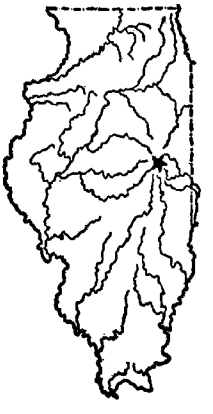
UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

BULLETIN No. 191

SUMMARY OF ILLINOIS SOIL INVESTIGATIONS

By CYRIL G. HOPKINS, J. G. MOSIER, AND F. C. BAUER



URBANA, ILLINOIS, DECEMBER, 1916

Summary of Bulletin No. 193

1. The Illinois Agricultural Experiment Station has been conducting extensive investigations upon the improvement of Illinois soils for the past fifteen years by means of a systematic soil survey, chemical analysis, and culture experiments. Pages 451–462

2. Field investigations have been conducted upon fifty experiment fields located upon representative types of soil in various parts of the state. Thirty-nine of these fields are in operation at the present time. Pages 454–459

3. Illinois soils exist in fourteen great soil areas, as shown on the colored map. Pages 463–464

4. In the counties covered by the first ten soil reports, 62 individual soil types have been discovered. These types are extremely diverse and for convenience are grouped into six classes; namely, prairie, timber, terrace, ridge, swamp and bottom-land, and residual soils. Pages 464–465

5. The fertility invoices of the individual soil types show a great variation in the content of the essential plant-food elements. Illinois soils may be deficient in one or more of five plant-food elements; namely, nitrogen, phosphorus, potassium, calcium, and magnesium,—and they may be either acid or alkaline. Thus the problem of maintaining the fertility of the soil is sometimes complicated, tho usually limited essentially to the application of limestone and phosphorus and the turning under of nitrogenous organic matter. Pages 465–467

6. As a rule, the results of the field experiments harmonize with the information given by the chemical composition of the soil. They have shown: (1) that the maintenance of organic matter and nitrogen is the greatest practical problem of the Illinois farmer; (2) that phosphorus is the one element of plant food that is most universally deficient; and (3) that limestone must be supplied in abundance to many soils before they can be permanently improved. Pages 467–483

7. On the ordinary corn-belt soil, proper treatment has produced a total value for one rotation (1911-1914) of $98.58, as contrasted with $65.00 where no treatment was given. One dollar invested in rock phosphate has paid returns as follows: first rotation, $1.18; second rotation, $1.62; third rotation, $2.70. Pages 473–475

8. Southern Illinois prairie land has been improved by proper soil treatment so that the total increase over untreated land has been 207 percent. Page 477

9. On peat soil, potassium has increased corn yields by more than 30 bushels per acre. Page 482

10. On sand soils, during six years the value of the crops per acre has been increased $75.37 by nitrogen and only 22 cents by phosphorus in addition. Page 482

11. Every farmer should practice a high-grade system of permanent agriculture. This is made possible by good crop rotation and the application of materials economically supplementing soil deficiencies. Page 483

SUMMARY OF ILLINOIS SOIL INVESTIGATIONS

By CYRIL G. HOPKINS, Chief in Agronomy and Chemistry
J. G. MOSIER, Chief in Soil Physics, and
F. C. BAUER, Associate in Soil Fertility

The wealth of Illinois is in her soil, and her strength lies in its intelligent development.—Draper.

The purpose of this bulletin is to summarize the results of the soil investigations which have been carried on by the Illinois Agricultural Experiment Station, in order that the farmers and landowners may know of the progress being made, and thus hasten the adoption of systems of farming that will increase and permanently maintain the productive capacity of Illinois soils, instead of decreasing their fertility, as is done under the most common practices.

NATURE AND EXTENT OF INVESTIGATIONS

The Illinois Agricultural Experiment Station began to investigate the soils of the thirty-six million acres of land within the borders of the state in 1901, with an appropriation from the General Assembly of $10,000 per annum for two years. In other words, this huge task was begun with an annual appropriation of one cent for each thirty-six acres. The growth of the work has since been so rapid and its value so evident that there is now an appropriation of one cent annually for about every four acres.

The purpose of these investigations has been five-fold, for the intelligent use of Illinois soils requires definite knowledge in regard to: (1) the plant-food requirements of the crops to be produced; (2) the total stock of plant food contained in the soil; (3) the availability of the plant-food elements by practical methods of farming; (4) the most practical economical methods of supplementing or increasing the plant food in the soil; and (5) the systems of farming that will most profitably and permanently maintain the productive capacity of the soil. Such knowledge has been rendered possible by means of systematic soil survey, chemical analysis, and culture experiments.

Soil Survey

The soil survey has furnished much valuable information: first, by establishing by a general survey the existence of extensive soil types in the great soil areas into which the state is naturally divided; and

second, by determining by detailed county survey the soil types upon every farm in the state. This detail survey when completed and mapped will give every farmer and landowner definite information concerning the soils upon his own farm, even down to ten-acre units or less.

A map showing accurately the location and extent of the different soil types, with their principal variations and limits, is essentially the objective of the soil survey. During the fifteen years the work has been in progress, a general survey of the state has been made and more than sixty counties have been completely, or almost completely, surveyed in detail, in such order that every unsurveyed county borders two or more surveyed counties. At the present rate of progress the detail survey of the state should be completed in six or seven years.

CHEMICAL ANALYSIS

Chemical analysis of the soil has furnished an accurate invoice of the total amounts of the different essential elements of fertility contained in the soil to a depth to which plant roots normally extend. For obvious reasons this soil depth is divided into three strata: the surface, the subsurface, and the subsoil. The surface soil extends to the depth of good plowing (0 to 6⅔ inches) and is that part with which the farm manure, limestone, phosphate, or other fertilizer is incorporated, and that part which must be depended upon largely to furnish the necessary plant food for the production of crops. The subsurface soil lies between the depths of 6⅔ and 20 inches, and may be stirred by subsoiling. The subsoil extends from 20 to 40 inches.

After a county has been surveyed, representative samples of every soil type established by the survey are secured from each of the three strata. Great care is used in every case to avoid the taking of samples that would not in every way be true to the soil type. Old stack yards and feed lots and fields that have been heavily manured or fertilized are avoided, and all other abnormalities are guarded against. When a suitable area has been selected, many soil samples are drawn at different places some rods apart. The samples of each stratum are thoroly mixed and about ten pounds of the mixed soil is then bagged and given an official number. An exact record is also kept of the location from which the samples have been taken. Extensive types are sampled many times in the county; less extensive types are sampled as they occur.

The soil samples thus secured are sent to the Station laboratories, where they are prepared for analysis by thoro air-drying and pulverizing. The pulverizing consists, first, in reducing the entire sample to such condition that it will pass thru a millimeter sieve (25 holes to the linear inch), a record being kept of the amount of pebbles, rock, and other material that will not pass thru; and for certain determina-

tions it consists further in reducing about 100 grams of this soil to such fineness that it will all pass thru a sieve having 10,000 holes to the square inch. In all, nine different determinations are then made, as follows: for dry matter, for total organic carbon, total nitrogen, total phosphorus, total potassium, total calcium, total magnesium, total inorganic carbon for the presence of limestone, and for soil acidity, these being the most important plant-food elements and soil characteristics which are more or less under the control of the farmer. After the soil is analyzed, the reserve is stored away in vaults for any possible future use, such, for example, as determining the degree of solubility in various solvents, in case conditions should ever justify such work.

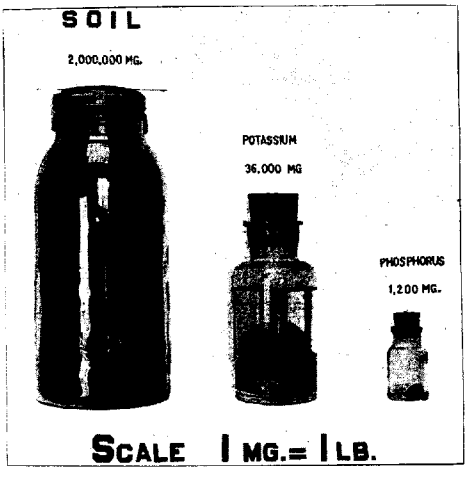


FIG. 1.—PROPORTIONATE AMOUNTS OF POTASSIUM AND PHOSPHORUS IN THE SURFACE SOIL OF AN ACRE OF TYPICAL CORN-BELT SOIL

All results of the chemical analyses are reported on the acre basis, assuming the weight of the surface soil to be 2 million pounds; the subsurface, 4 million pounds; and the subsoil, 6 million pounds. In the case of sand soils, however, 2½ million, 5 million, and 7½ million pounds, respectively, are used as the bases, and for peat soils, 1 million, 2 million, and 3 million pounds, on account of the difference in the specific gravities of these types. The results are so reported because they are easily understood and readily compared in practical application, and they are also scientifically exact.

Since the beginning of the work about 7,000 samples of soil have been collected from various parts of the state, and of this number approximately 4,600 have been analyzed. At the present rate of collecting and analyzing the samples (about five counties a year), twelve to thirteen years will be required to complete the work for the entire state.

EXPERIMENT FIELDS

Culture experiments have been conducted by the University upon experiment fields established in all sections of the state upon important and representative soil types. The fields are so operated as to give the farmer positive information upon practical, economical, and permanent systems of soil management. Such experiments have been conducted on fifty fields in various parts of the state, thirty-nine of which are in operation at the present time.

The first fields were established in the summer and fall of 1901 upon rented tracts of land. More or less difficulty prevailed at that time in securing suitable tracts because in many cases the farmers had little interest or confidence in the work; but this indifference gradually changed to real interest, and at the end of six years the University was operating twenty fields.

By 1908 the value of such fields for purposes of investigation and demonstration of soil improvement methods began to impress many people. Suitable tracts of land for such experiments were then offered and donated permanently to the University by local communities and individuals, and from thenceforth the University has established no field except upon permanently deeded land. In recent years many more such tracts have been offered than could be accepted.

In establishing a permanent field, it is the policy of the University to choose a location where the results will, in every respect, be of the greatest value to the community. The land above all must be uniform in order that practical and trustworthy information may be secured. It must represent an extensive soil type so that the results secured from different systems of farming will be widely applicable to the conditions of the community. It should be upon a main thoroughfare and within easy walking distance from railroad stations so that it will be easily accessible to visitors.

As new and permanent fields have been established, a number of the older temporarily rented fields in the same general locality have been given up, sometimes because the lease expired and could not be renewed. Fields that have been discontinued were located near the following places: Myrtle, Ogle county; Tampico, Whiteside county; Green Valley, Tazewell county; Lincoln, Logan county; Manito (old field), Mason county; Sibley, Ford county; Auburn, Sangamon county; Manito (new field), Tazewell county; Mascoutah, St. Clair

county; Vienna (fertility field), Johnson county; and Momence, Kankakee county.

At the present time twelve rented fields are still being operated, six of them temporarily and six with perpetual leases. Some of the former will undoubtedly have to be discontinued sooner or later on account of the impossibility of securing permanent possession of the land. These temporary fields are located near the following places: Antioch, Lake county; DeKalb, DeKalb county; Fairfield, Wayne county; Galesburg, Knox county; McNabb, Putnam county; and Rockford, Winnebago county. The six fields which may be permanently retained by the University are located near Odin, Marion county; Cutler, Perry county; Bloomington, McLean county; DuBois, Washington county; Union Grove, Whiteside county; and Virginia, Cass county.

In addition to the six permanently leased fields, the University has secured possession of twenty-seven fields so long as they are used for agricultural experimentation or demonstration. The permanent fields now owned by the University or controlled without rental expense are located as follows:

(1) Aledo experiment field, Mercer county, about one-half mile west of the railway station at Aledo. The land was purchased and donated by the business men and landowners of Aledo and vicinity, in part thru the efforts of William and Vashti College.

(2) Carlinville experiment field, Macoupin county, part of an eighty-acre tract on which Blackburn College is located. The permanent possession and use of this land was a direct donation from Blackburn College.

(3) Carthage experiment field, Hancock county, within the corporate limits of Carthage, about five blocks south of the courthouse. The land was purchased and donated by the business men and landowners of Carthage and vicinity, partially on account of their interest in Carthage College.

(4) Clayton experiment field, Adams county, adjoining the town of Clayton. The field is about five blocks south of the railway station, and reached by a concrete walk. The land was donated by the citizens of Clayton and vicinity.

(5) Dixon experiment field, Lee county, on the north side of the interurban railroad about two miles west of Dixon. The land was purchased and donated by the citizens of Dixon and vicinity.

(6) Enfield experiment field, White county, three-quarters of a mile northeast of the town of Enfield. The land was purchased and donated by about six hundred citizens of White county.

(7) Ewing experiment field, Franklin county, about one-half mile northeast of the village of Ewing. The land was purchased and donated by Ewing College with the assistance of friends of that institution.

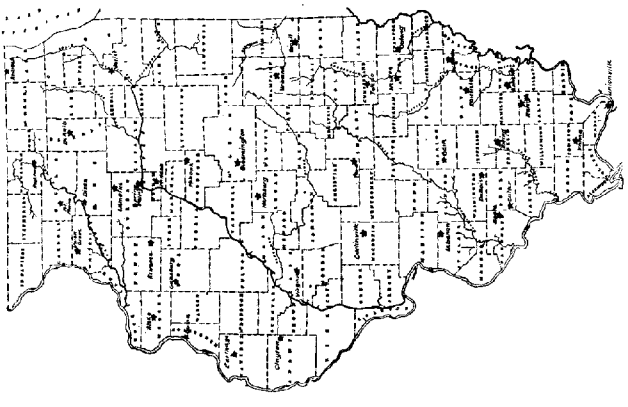


FIG. 2.—A STAR INDICATES THE LOCATION OF AN EXPERIMENT FIELD

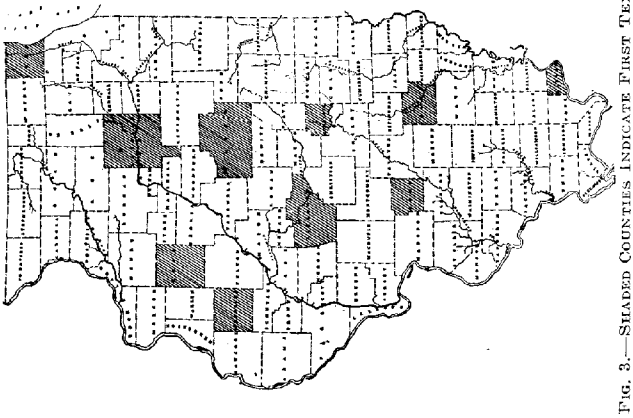


FIG. 3.—SHADED COUNTIES INDICATE FIRST TEN COUNTIES FOR WHICH SOIL REPORTS HAVE BEEN PUBLISHED

(8) Hartsburg experiment field, Logan county, about one-half mile east of the village of Hartsburg. This land was donated by the Scully estate.

(9) Joliet experiment field, Will county, three miles northwest of Joliet, on the Joliet-Plainfield wagon road and the Aurora-Joliet interurban line. The land was purchased and donated by Will county.

(10) Kewanee experiment field, Henry county, about midway between Kewanee and Galva on the Galva and Kewanee electric line. The car stops at Midland about one-half mile south of the field. The land was purchased and donated by the citizens of Kewanee, Galva, and vicinity.

(11) LaMoille experiment field, Bureau county, about one mile south of the corporate limits of LaMoille. The land was donated by Mrs. Anna Norris Kendall, and was a part of the farm on which her own residence, "Elizabeth Cottage," is located.

(12) Lebanon experiment field, St. Clair county, about five blocks south of the main street of Lebanon. The land was purchased and donated by McKendree College, the purchase price being contributed for the purpose by Governor Charles S. Deneen, an alumnus and trustee of McKendree and at the time an ex-officio trustee of the University of Illinois.

(13) Minonk experiment field, Woodford county, one mile west of Minonk. This land was donated by Mr. and Mrs. Bela M. Stoddard, of Minonk.

(14) Mount Morris experiment field, Ogle county, immediately adjoining the residence district on the south side of Mount Morris. The land was purchased and donated by Mount Morris College and citizens of Mount Morris and vicinity.

(15) Newton experiment field, Jasper county, about one and one-half miles northwest of Newton. The land was purchased and donated by Jasper county and the citizens of Newton and vicinity.

(16) Oblong experiment field, Crawford county, five blocks south of the station at Oblong. The land was purchased and donated by the citizens of Oblong and vicinity.

(17) Oquawka experiment field, Henderson county, about one mile northeast of the C. B. & Q. station at Oquawka. The field was donated by Mr. Alex Moir and others.

(18) Pana experiment field, Christian county, just north and east of Pana, one mile from the Big Four and Illinois Central passenger station. This field was donated by the late Captain Kitchell, of Pana.

(19) Raleigh experiment field, Saline county, one-half mile south of Raleigh, on land purchased and donated by citizens of Raleigh, Galatia, and vicinity.

(20) Sidell experiment field, Vermilion county, one mile directly east of Sidell. The land was purchased and donated by the citizens of Sidell and vicinity.

(21) Sparta experiment field, Randolph county, immediately north of the city of Sparta. The land was purchased and donated by the citizens of Sparta and vicinity.

(22) Spring Valley experiment field, Bureau county, about one-half mile from the business part of Spring Valley. The land was donated by the vocational township high school of Spring Valley.

(23) Toledo experiment field, Cumberland county, about one-half mile south of the courthouse at Toledo. The land was purchased and donated by the county.

(24) Urbana experiment field, Champaign county, on the University farm. Part of this field has been under continuous experiment for thirty-seven years. So far as is known, it is the oldest experiment field in the United States on which the originally planned experiments are still in progress. It is unquestionably the most valuable land within the borders of the state, considering the annual lesson it now presents to the agricultural world.

(25) Brookport-Unionville experiment field, Massac county, adjoining the village of Unionville, five miles east of Brookport, on land purchased and donated by citizens of Massac county and southern Pope county. This experiment field is located on the most southern table land of the state, within five miles of the mouth of the Tennessee river, which flows northward from Alabama and is said to modify appreciably the temperature of the Ohio river below Paducah and Brookport.

(26) Vienna experiment field, Johnson county, about one mile south of Vienna.[1] This field is rolling hill land and is devoted to a special study of surface washing and methods for its prevention. On part of the field destructive erosion is permitted to continue, as an object lesson. The land cost $20 an acre.

(27) West Salem experiment field, Edwards county, three-quarters of a mile southwest of the station at West Salem. The land was purchased and donated by the citizens of West Salem and vicinity.

Thirty-six of the thirty-nine fields listed here are operated primarily to give Illinois farmers the most complete information possible upon systems of farming that will permanently maintain or increase the productive capacity of their soils. Of the three remaining, the fields near DeKalb in DeKalb county, and near Fairfield in Wayne county are given over mainly to crop investigations, and the Vienna field, as has been stated, is devoted to the study of methods of preventing soil washing and erosion. The distribution of these experiments fields is shown by Fig. 2.

[1]This tract is in addition to the leased land mentioned in the list of discontinued fields, page 454.

PLAN AND METHODS OF FIELD INVESTIGATIONS

Each experiment field contains on the average about twenty acres of land, divided into series which correspond to the different fields upon a farm. Each series is further divided into smaller areas, usually ten fifth-acre plots, and these are treated in such a manner that positive information can be secured in regard to the needs of the soil. Untreated plots are retained as checks in order to determine the effect of every kind of soil treatment applied.

Crops are grown upon these fields in a definite rotation. On some fields two or more rotations are being tried. There are usually a sufficient number of series so that the crops of the main rotation are represented every year. The crops grown are those common to the locality and include wheat, corn, oats, barley, red clover, alsike, sweet clover, alfalfa, cowpeas, soybeans, vetch, timothy, and potatoes.

Altho there may be a number of ways of meeting the needs of the soil with respect to better production, the Illinois Agricultural Experiment Station makes use largely of natural methods and natural materials. Instead of applying expensive complete fertilizers, which may produce a more or less rapid response, wide use is made of such natural materials as farm manure, legume crops, crop residues, ground limestone (both ordinary and dolomitic, each of which is found in abundance in Illinois), steamed bone meal (a farm product), and ground natural raw rock phosphate. Abundant information points to the fact that in the long run and under normal conditions the use of these materials in well planned systems of farming usually proves to be the most practical and economical method of soil improvement. In some comparative experiments and on some abnormal soils, purchased nitrogen, manufactured acid phosphate, potassium salts, and other commercial fertilizers are used.

In order that the reader may better understand the operation of a typical experiment field, the arrangement and methods used on the field located at Urbana are here described. The accompanying diagram of the field shows the manner in which the series and individual plots are arranged. The treatment given each plot and the method of numbering is indicated thereon. Each plot covers exactly one-tenth of an acre.

A combination rotation is practiced which is well suited to the farming conditions of this region of the state. Corn, oats, clover, and wheat, in the order named, rotate once completely over four fields while a fifth field is in alfalfa. After the four crops have been rotated over the four fields for five years, the alfalfa is changed to one of the other fields, and the old alfalfa field is then used in the four-year rotation. This is repeated until the alfalfa again occupies the same field. The whole rotation will cover a period of twenty-five years.

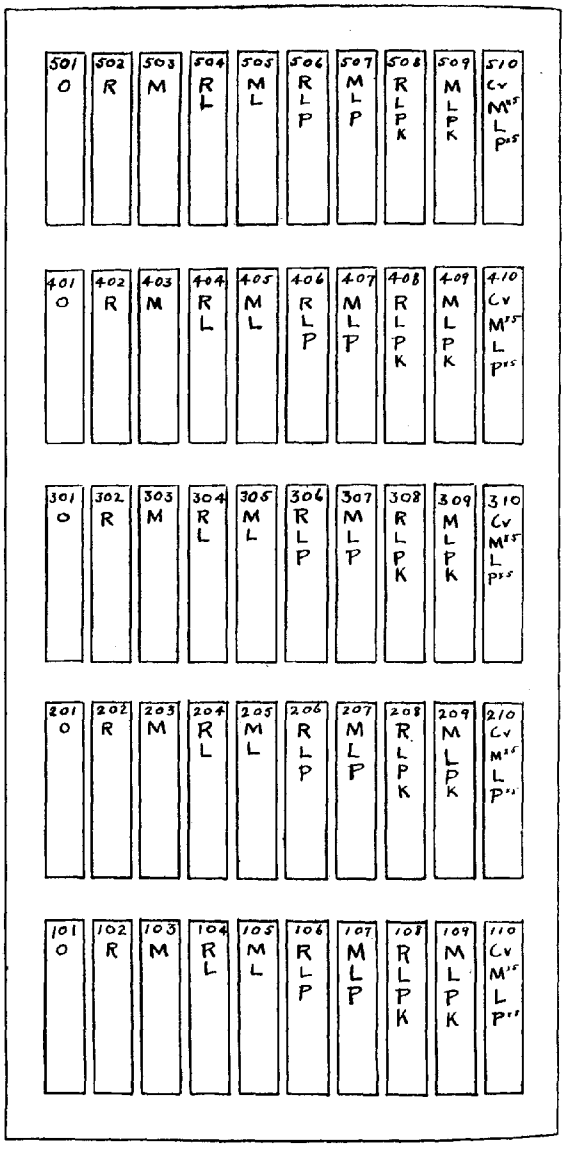


FIG. 4.—DIAGRAM OF URBANA EXPERIMENT FIELD

0=No treatment; M=Manure; L=Limestone; P=Phosphorus; R=Residues (corn stalks, straw of wheat and oats, and all legumes except seed); K=Potassium; Cv=Cover crop

As may be noted from the diagram, two different systems of farming are practiced; namely, a live-stock system and a grain system. In the live-stock system, the feed grains and all the hay and forage (corn stalks and straw) are used for feed and bedding. The resulting manure is returned to the land and constitutes the important source of nitrogen and organic matter for soil improvement. In the grain system, the nitrogen and organic matter are maintained by plowing under all crop residues after the seed is removed (corn stalks, the straw from wheat, oats, soybeans, clover, etc., and some cover crops). Under this system, the grain, the alfalfa, and the clover or other legume seed are marketed. Alfalfa is regarded as a money crop, since sufficient residues are provided in the regular four-year rotation to supply the needs of the non-legumes for nitrogen.

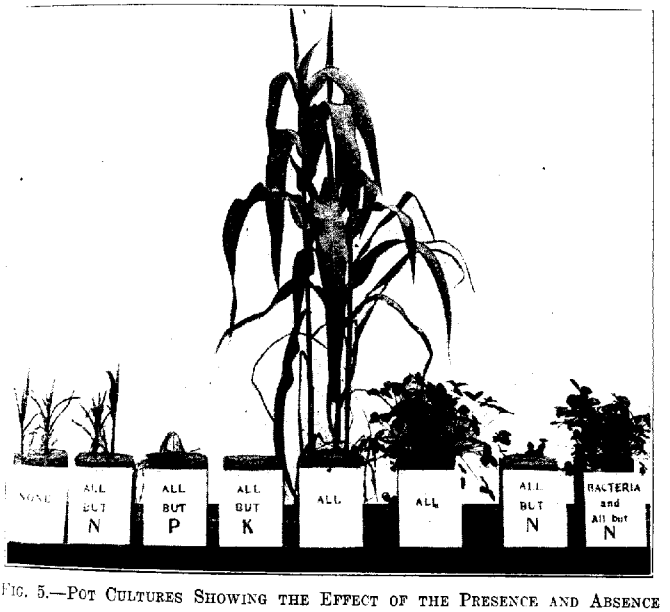


FIG. 5.—POT CULTURES SHOWING THE EFFECT OF THE PRESENCE AND ABSENCE OF PLANT FOODS

(Observe that inoculated clover without applied nitrogen grows as luxuriantly as uninoculated clover supplied with commercial nitrogen)

In both systems of farming there are check plots which do not receive any treatment. The only benefits the soil receives are those which are incidental to the rotation. Everything is removed from the land, and nothing returned; which means a gradual decrease in pro-

ductive power and eventual land ruin. The purpose of these plots is to show by comparison the value of the treatment. The other plots receive additional treatments in such a way that the definite needs of the soil may be determined; whether it be manure or residues alone, or lime in addition, or lime and phosphorous in addition, that must be supplied in order to insure greater production. To two plots in the series, potassium is added in order to obtain information in regard to the possible need for that element. In both systems of farming, provision is made for the maintenance and the increase of those elements of plant food and those physical conditions necessary for the best plant growth as indicated by the soil survey, the soil analysis, and other sources of knowledge.

VALUE OF INVESTIGATIONS

The value of these investigations as the results are disseminated is to make clear the vital facts that the productive power of the soil depends upon its ability to feed the plant, and that low production is due to deficiencies of the soil and to poor methods of management. The problems of better farming will be solved only when the investigations reveal the location and extent of every kind of soil in the state; positive information as to the extent and depletion of the fertility; whether, in the case of normal soils, limestone, phosphorus, and nitrogenous organic matter, in this order or in some other order, are required; or whether, in the case of abnormal soils, some one essential element may be almost entirely lacking, such as potassium in peaty soils; in what cases some injurious substance must be removed or neutralized in a soil that may be rich in all essentials; and, in general, how the needs of the soil may be supplied in the most practical and economical manner in order that permanent and profitable systems of agriculture may be established.

SOIL PUBLICATIONS

The information secured by the soil survey, chemical analysis, and field-culture experiments is disseminated by means of circulars, bulletins, and soil reports.[1] The circulars are usually concerned with some special phase of soil improvement and are of general interest to the farmers of the state. The bulletins report the results of investigations upon Illinois soils with respect to specific problems, and most important of these is Bulletin 123, "The Fertility in Illinois Soils," which appeared immediately after the completion of the general soil survey of the state in 1907. This publication reports the stock of fertility contained in twenty-five of the most important and extensive types of soil in the state, and the results of field experiments previously conducted on the more extensive soil types to ascertain prac-

[1] See page 484 for a list of available publications.

tical methods of soil improvement. This information can be applied to more than half the soils of the state.

Soil reports are published for each county after the detail soil survey has been made and the essential information collected. Each report contains a colored map showing the location and extent of every soil type in the county, an invoice of the total stock of fertility, a record of the results of field experiments, a description in more or less detail of the essential characteristics of each soil type, the interpretation of the data presented, and an exposition of the principles of soil improvement involved. Such a publication gives the reader a complete text and reference book upon the soils of the county concerned. Previous to the preparation of this bulletin, soil reports had been published for ten counties; namely, Clay, Moultrie, Hardin, Sangamon, LaSalle, Knox, McDonough, Bond, Lake, and McLean.

The location of the first ten counties for which soil reports have been published is shown by Fig. 3, page 456. As may be seen from the order of publication of the reports and the wide distribution of the counties over the state, the selection has been made with a view to rendering the largest benefit to the great sections of the state. Thus the Clay county report gives information, not only to the farmers of Clay county, but also to that great section of the state, the wheat belt, located in what is known as the lower Illinoisan glaciation (see colored map), for Clay county is quite similar to the other counties of this region. In the same way the second report, Moultrie county, represents the southern part of the great corn belt of the state, especially so far as it lies in the early Wisconsin glaciation. The third report, Hardin county, represents the unglaciated area in the extreme southern part of the state, etc., etc.

THE SOILS OF ILLINOIS

THE LARGE SOIL AREAS

Geological investigations indicate that at one time glaciers or ice sheets covered the greater portion of Illinois. An immense amount of miscellaneous material was collected and carried along by these glaciers, and large deposits of boulder clay or glacial till were formed by the tremendous grinding of accumulated material between the ice of the glaciers and the surface of the earth over which the glaciers passed. The drift material which resulted includes clay, silt, sand, and some coarser material varying in size from pebbles to boulders. Wherever the forward movement of the glacier just kept pace with the melting of the ice, a large amount of material was deposited, forming moraines or glacial ridges—elevations of various sizes which now mark the boundaries of the glacier last covering the territory. With the final melting and disappearance of the ice, a great deal

of finely reduced rock material was scattered and transported over other territory by water and wind. The wind-blown material, known as loess, is found in almost all parts of the state at depths varying from three feet or less to one hundred feet or more near the Mississippi and Illinois rivers.

During the Glacial period, glaciers advanced, receded, and advanced again, over the same or different territory. Thus, at the end of the Glacial period, large soil areas existed which now differ principally on account of age. Following an earlier glaciation known as the Kansan, which entered the state from the west, it is believed that there were three main glaciations in Illinois. The first, called the Illinoisan, probably made three advances, now marked more or less distinctly by terminal moraines, ridges, etc. The oldest of these advances is designated as the lower Illinoisan, the second as the middle Illinoisan, and the third as the upper Illinoisan. In the same way the second glaciation is now known as the pre-Iowan and the Iowan, and the third as the early Wisconsin and the late Wisconsin. The great areas covered by these glaciations, together with the unglaciated areas, the areas of deep loess, the moraines, and the early and the late bottom and swamp lands, constitute the fourteen great soil areas of Illinois, as may be seen by the accompanying map.

INDIVIDUAL SOIL TYPES

Within these great soil areas, sixty-two individual soil types have been identified by detail soil survey in the first ten counties for which reports have been published. These soils are extremely diverse and vary considerably with respect to fertility and to physical characteristics, but for convenience and ready comparison they may be grouped into six general classes as follows:

(1) Upland prairie soils, rich in organic matter. These were originally covered with wild prairie grasses whose network of roots was protected from complete decay by the imperfect aeration resulting from the covering of fine soil material and the moisture it contained. The flat prairie land is richer in organic matter because there the grasses and roots grew more luxuriantly and the higher moisture content preserved them still further from decay. The upland prairie soils vary in topography from level to rolling, and include gray silt loam on tight clay of the lower Illinoisan glaciation, which is the extensive type in the wheat belt; brown silt loam, the most common corn-belt soil, found extensively in the middle and upper Illinoisan and the early Wisconsin glaciations; and the heavy black clay loam, of a somewhat swampy nature before drainage, found in the very flat prairies in the corn-belt glaciations.

(2) Upland timber soils, including those zones along stream courses upon which forests have grown for a long period of time.

These soils are characterized by a yellow, yellowish gray, or gray color, which is due to their low organic-matter content. This lack of organic matter is the result of the long-continued growth of forest trees, for as the forest invaded the prairies two effects were produced: the shading of the trees prevented the growth of the prairie grasses, and the trees themselves added very little organic matter to the soil since the leaves and branches either decayed completely or were burned by forest fires. The timber lands are divided chiefly into two classes, the undulating and the hilly areas.

(3) Terrace soils, formed on terraces or benches, in valleys. These soils are largely the result of the deposition of material from overloaded streams during the melting of the glaciers. The streams of these partly filled valleys later cut thru the deposit and formed new bottom lands or flood plains at a lower level, leaving the old fill as a terrace. From this action, first and second bottoms have resulted.

(4) Ridge soils, including those on morainal ridges, most of which have been forested.

(5) Swamp and bottom-land soils, which include the flood plains along streams and the peaty swamp areas.

(6) Residual soils, formed by the accumulation of loose material resulting from the weathering of rocks in place. Very little of this class of soils exists in Illinois owing to the action of the glaciers in removing the residual material and covering it with glacial drift.

FERTILITY INVOICE

The fertility invoice of the more extensive soil types of the state—those occupying 5 percent or more of a county—is given in Table 1. The results reported are as a rule averages of many analyses, which like most things in nature show more or less variation, but for all practical purposes these averages are most trustworthy and sufficient.

In studying this table, it will be well to keep in mind that the most productive soils of normal physical composition contain in the surface soil of an acre about 8,000 pounds of total nitrogen, 2,000 pounds of total phosphorus, and more than 30,000 pounds of total potassium. It will be noted here that some soils are extremely poor in the essential elements of fertility, while others are abundantly supplied. From the standpoint of the productive power of soils, nitrogen and phosphorus are the most extensively deficient elements of plant food. Nitrogen varies from about 900 pounds per acre in yellow silt loam to over 8,000 pounds in black clay loam and about 33,000 pounds in peat. Phosphorus varies from about 600 pounds per acre in some of the upland timber soils to 2,000 pounds in some of the upland prairie soils.

Figured on the basis of 100 bushels of corn per acre, the grain only being removed, the common corn-belt prairie land contains in

TABLE 1.—FERTILITY OF THE MORE IMPORTANT TYPES OF ILLINOIS SOILS

Average pounds per acre in 2 million pounds of surface soil (about 0—6⅔ inches)

Soil type No.	Soil type	Soil area, or glaciation	Total organic carbon	Total nitrogen	Total phosphorus	Total potassium	Total magnesium	Total calcium	Limestone present	Soil acidity present
Upland Prairie Soils										
426	Brown silt loam	Middle Illinoisan	51 680	4 070	1 030	34 620	7 470	9 280		50
526		Upper Illinoisan	57 780	4 705	1 149	32 910	9 732	11 930		70
1126		Early Wisconsin	60 350	5 260	1 161	35 378	8 855	11 716		70
1226		Late Wisconsin	89 950	7 490	1 430	46 930	12 680	13 300		50
330	Gray silt loam on tight clay	Lower Illinoisan	26 295	2 715	760	26 120	2 700	4 310		845
420	Black clay loam	Middle Illinoisan	63 570	5 040	1 330	31 870	11 090	15 990	2 850	
1120		Early Wisconsin	91 370	8 160	2 000	34 210	16 580	31 240	Often	Rarely
328	Brown-gray silt loam on tight clay	Lower Illinoisan	29 490	2 840	670	31 040	4 590	6 210		100
528		Upper Illinoisan	39 800	3 400	900	31 740	6 400	8 200		100
Upland Timber Soils										
135	Yellow silt loam	Unglaciated	12 880	1 250	840	34 200	7 710	3 980		2 100
335		Lower Illinoisan	19 550	1 804	603	33 727	5 122	4 020		1 595
435		Middle Illinoisan	10 240	920	820	40 020	7 210	6 440		470
535		Upper Illinoisan	23 440	2 235	825	36 815	6 790	7 495		60
1235		Late Wisconsin	20 900	1 880	720	58 300	12 380	6 270		30
134	Yellow-gray silt loam	Unglaciated	15 600	1 520	870	29 150	5 510	4 390		40
334		Lower Illinoisan	23 020	2 090	510	32 850	5 680	6 120		180
434		Middle Illinoisan	26 160	2 300	1 010	35 970	5 390	7 100		30
534		Upper Illinoisan	26 485	2 530	870	35 400	6 455	8 202		75
1134		Early Wisconsin	31 504	2 592	921	36 880	6 437	7 439		109
1234		Late Wisconsin	32 220	2 720	750	46 300	9 210	7 820		40
198	Stony loam	Unglaciated	15 600	840	480	25 040	3 420	4 300		1 520
Swamp and Bottom-Land Soils										
1326	Deep brown silt loam	Old river bottoms and swamp land	53 965	4 745	1 765	36 675	9 695	11 545		45
1331	Deep gray silt loam		32 335	3 015	1 545	36 490	8 430	7 480		90
1361.1	Mixed fine sandy loam		13 900	1 290	650	29 480	4 990	4 910	840	
1426	Deep brown silt loam	Sand, late swamp and bottom land	51 140	4 450	1 630	41 350	10 630	11 700	700	
1401	Deep peat		398 040	32 570	1 540	3 900	6 260	24 970		140

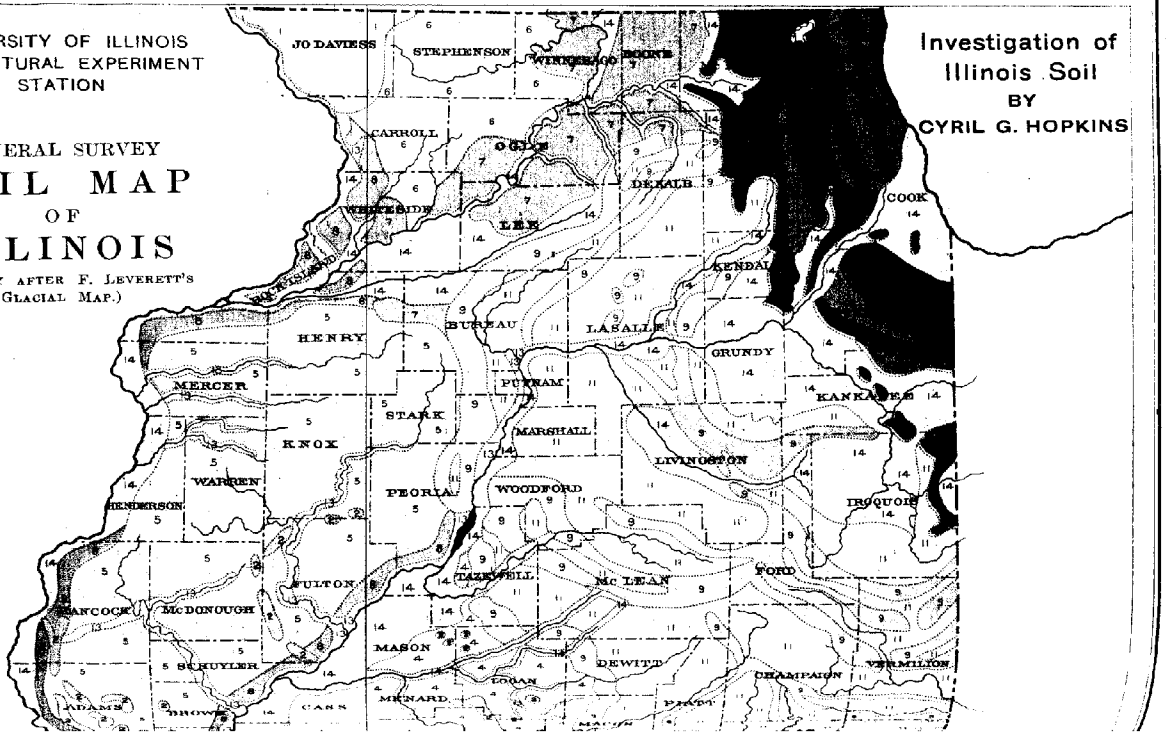
UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT
STATION

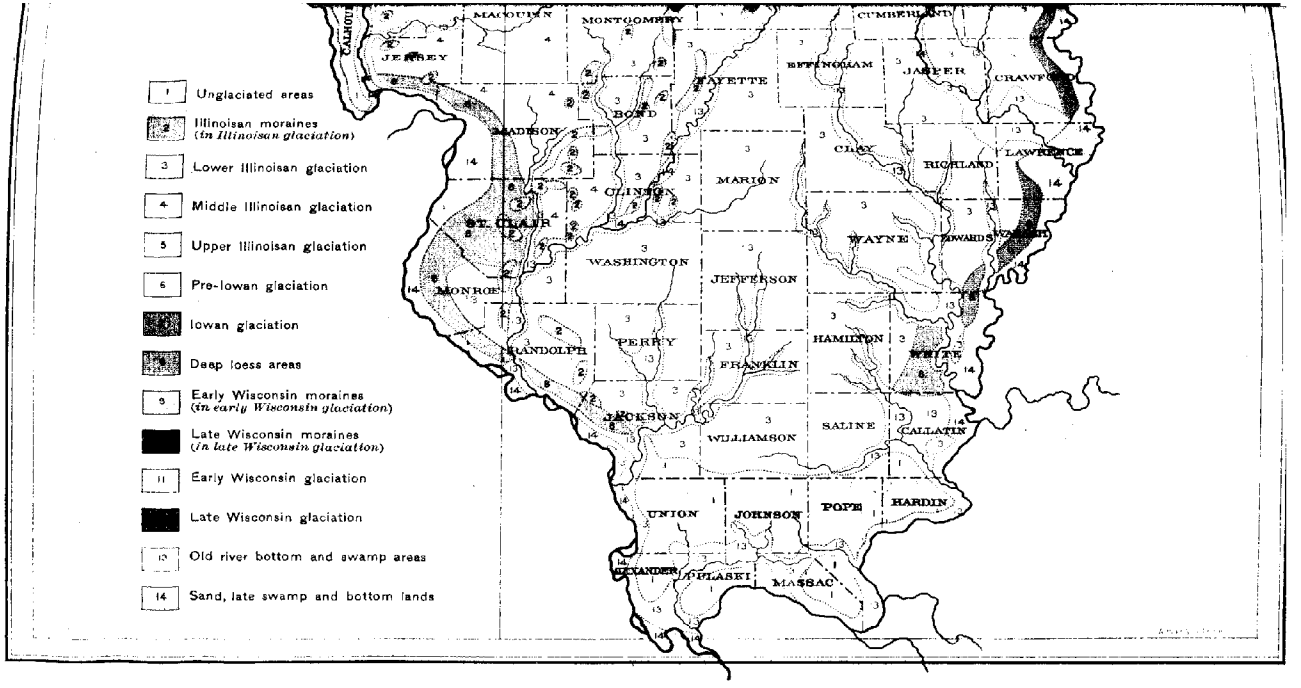
GENERAL SURVEY

SOIL MAP OF ILLINOIS

(CHIEFLY AFTER F. LEVERETT'S GLACIAL MAP.)

Investigation of
Illinois Soil
BY
CYRIL G. HOPKINS




1 Unglaciated areas
2 Illinoisan moraines (in Illinoisan glaciation)
3 Lower Illinoisan glaciation
4 Middle Illinoisan glaciation
5 Upper Illinoisan glaciation
6 Pre-Iowan glaciation
Iowan glaciation
Deep loess areas
9 Early Wisconsin moraines (in early Wisconsin glaciation)
Late Wisconsin moraines (in late Wisconsin glaciation)
11 Early Wisconsin glaciation
Late Wisconsin glaciation
13 Old river bottom and swamp areas
14 Sand, late swamp and bottom lands
MACOUPIN
MONTGOMERY
CUMBERLAND
JERSEY
EFFINGHAM
JASPER
FAYETTE
BOND
MADISON
CLAY
RICHLAND
MARION
CLINTON
ST. CLAIR
WAYNE
WASHINGTON
JEFFERSON
MONROE
RANDOLPH
PERRY
HAMILTON
FRANKLIN
JACKSON
WILLIAMSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
ALEXANDER
PULASKI
MASSAC

the surface about enough nitrogen for 48 crops and sufficient phosphorus for 70 crops. On the other hand, it contains enough potassium to produce 1,790 such crops; and with good methods of farming, potassium may be renewed rapidly enough from the subsoil, by unavoidable surface washing, to maintain the potassium content of the soil indefinitely. If production is to be maintained, it will be necessary, therefore, to supplement the supply of nitrogen and phosphorus in these soils. The necessity for the use of organic matter is indicated by the ratio of nitrogen to organic carbon. A narrow ratio exists where the organic-matter content is low, and a wide one where there is sufficient of this material present.

Measured by actual crop requirements, some of these soils show a deficiency in the elements calcium and magnesium. Limestone, therefore, in addition to correcting soil acidity, may have considerable value for the calcium and magnesium which it contains.

While the amount of plant food contained in the subsurface and subsoil strata is of interest, no analyses for these strata are reported here. The chief thing of importance in systems of permanent, profitable agriculture is the maintenance of a good surface soil, for even a rich subsoil is of but little value if it lies beneath a worn-out surface. For detailed discussion of the fertility in Illinois soils below the seven-inch depth, the reader is referred to the various soil reports issued by this station and to Bulletin 123.

RESULTS OF FIELD-CULTURE EXPERIMENTS

The field-culture experiments planned in connection with the information furnished by the soil survey and soil analysis have demonstrated that it is possible to practice a system of farming that is both permanent and profitable. A summary of the results secured upon a number of the most important soil types in the different soil areas, showing the effect and value of various forms of soil treatment, is presented upon the following pages. The data are arranged by soil types, which are presented according to age when occurring in more than one soil area.

Since a definite system of farming may or may not be profitable, depending upon the price received for produce, the field results are usually summarized in two sets of money values to emphasize this fact. Low prices are used to represent the value of the produce in the field, and high prices to represent the market value. The prices used are as follows: corn, 35 and 50 cents per bushel; oats, 28 and 40 cents; wheat 70 cents and $1; soybeans, 70 cents and $1 per bushel. Measured by average Illinois prices for the past ten years, the lower values are not too high for crops standing in the field ready for harvest. Unless otherwise specified, these are the values used in the following discussion.

UPLAND PRAIRIE SOILS

Black Clay Loam of Early Wisconsin Glaciation (1120)

Urbana Field.—At Urbana, on the South Farm of the University of Illinois, a series of plots devoted primarily to crop-production experiments extends across an area of black clay loam. A four-year rotation of wheat, corn, oats, and clover (or soybeans) is practiced. Where rock phosphate has been applied at the rate of 500 pounds an acre per annum in connection with crop residues in the grain system, the value of the increase per ton of phosphate has been as follows, in three successive rotations:

	Lower prices	Higher prices
First rotation	$2.13	$3.04
Second rotation	4.70	6.71
Third rotation	6.48	9.26

In the live-stock system, the phosphorus naturally supplied with the manure, supplemented by that liberated from this fertile soil, has been approximately sufficient to meet the crop requirements. The value of the increase per ton of phosphate, as an average of the twelve years, has been only $2.26 at the lower prices and $3.26 at the higher prices. These returns are less than half the cost of the phosphorus applied, and in some seasons no benefit has appeared.

Brown Silt Loam of Middle Illinoisan Glaciation (426)

Virginia Field.—At Virginia, in Cass county, the University established an experiment field in 1902 upon brown silt loam somewhat above the average in productive power. A three-year rotation was begun on three different series of plots. Corn, oats, and cowpeas were grown the first six years, after which the rotation was changed to corn, oats, and clover.

During the first seven years (1902 to 1908), phosphorus applied at the rate of 25 pounds per acre per annum in the form of steamed bone meal produced an increase of 6.8 bushels of corn, .4 bushel of oats, .04 ton of hay. During the next three years (1909 to 1911), the increases were 10.5 bushels of corn, 13.1 bushels of oats, and .69 ton of hay. These results were to be expected, for the chemical analysis of the soil shows that phosphorus is not abundant and that nitrogen is the first limiting element. Thus phosphorus could show no marked effect until nitrogen was gradually increased by the use of legume crops and farm manure.

On another series, commercial nitrogen was applied in a four-year rotation of corn, corn, oats, and wheat, thus giving an opportunity to compare this form of nitrogen to that supplied the soil by grain and live-stock farming. On plots treated alike with respect to lime and phosphorus, legumes in rotation and some crop residues plowed

under increased the six-year average yield of corn by 24.2 bushels, and farm manure and legumes increased the yield by 26.6 bushels; while 100 pounds of commercial nitrogen in about 800 pounds of dried blood, costing $15 to $20 per annum, increased the yield only 19.5 bushels.

The two important lessons from the Virginia field are: first, when nitrogen is the limiting element, nothing else can take its place, and, even tho phosphorus may be deficient, its addition will not produce marked results until sufficient nitrogen is provided; second, the growing of legumes in rotation and the use of crop residues or farm manure may produce even better results than high-priced commercial nitrogen. (For further details see Soil Report No. 4, Sangamon county.)

Brown Silt Loam of Upper Illinoisan Glaciation (526)

Galesburg Field.—Upon the experiment field located near Galesburg on brown silt loam prairie soil, a six-year rotation of corn, corn, oats, clover, wheat, and clover has been practiced. There are only three independent series of plots, so that while corn is grown every year, the other crops are harvested every other year, with the exception of clover, which should be on the field every year either as a regular crop or in the stubble of oats and wheat.

The twenty plots of each series are so treated that the value of additions, consisting of phosphorus in the form of rock phosphate, potassium, and limestone, may be known in both live-stock and grain farming (see page 461). On Plot 19 of the three series, commercial nitrogen at the rate of 25 pounds an acre per annum is used in addition to the regular treatment.

Three facts are clearly brought out by the data from this field:

First.—Commercial nitrogen at 15 cents a pound has never paid its cost. As the system of providing "home-grown" nitrogen has developed, the effect of commercial nitrogen has decreased, and as an average of the five years 1908-1912 it paid back only 4 percent of its annual cost.

Second.—Potassium, likewise, has never paid its cost; but during the early years, with no adequate provision for decaying organic matter, the soluble potassium salts produced marked effect, owing no doubt in part to their power to make available the raw phosphate rock applied with the potassium. With the increase of organic matter, the effect of the potassium has been greatly reduced. As an average of the six years from 1907 to 1912, potassium costing $7.50 paid back only $1.

Third.—Fine-ground rock phosphate applied at the rate of 500 pounds an acre per annum in connection with decaying organic matter has paid back the following increases in crop values per ton of phosphate applied:

	Lower prices	Higher prices
Average 1904 and 1905	$3.53	$5.04
Average 1906-1908	7.73	11.04
Average 1909-1911	8.60	12.29
Average 1912-1914	12.93	18.49

These increases have been realized by the removal from the soil of only one-third of the phosphorus applied, leaving two-thirds in the soil as positive enrichment. (See Soil Report No. 6, Knox county, for detailed data on crop yields, etc.)

Brown Silt Loam of Early Wisconsin Glaciation (1126)

Sibley Field.—The Sibley experiment field, located in Ford county upon typical brown silt loam prairie soil, was cropped previous to 1902 with corn and oats under a tenant system which had caused the active organic-matter content to be somewhat deficient. One series of plots treated in such a manner as to bring out facts concerning the needs of the soil, in which phosphorus is the limiting element, has furnished some interesting information.

In 1903 the addition of phosphorus produced an increase of 8 bushels of corn, nitrogen produced no increase, but nitrogen and phosphorus combined increased the yield by 15 bushels. After six years of additional cropping, nitrogen appeared to become the most limiting element, the increase in corn in 1907 being 9 bushels from nitrogen and only 5 bushels from phosphorus, while nitrogen and phosphorus together produced an increase of 33 bushels. Thus even tho phosphorus was a limiting element, the nitrogen becoming available an-

TABLE 2.—VALUE OF CROPS PER ACRE IN TWELVE YEARS, SIBLEY FIELD 1902 TO 1913

Plot	Soil treatment applied	Total value of 12 crops	
		Lower prices	Higher prices
101	None	$172.89	$246.98
102	Lime	186.51	266.45
103	Lime, nitrogen	177.44	253.49
104	Lime, phosphorus	217.78	311.11
105	Lime, potassium	167.32	239.03
106	Lime, nitrogen, phosphorus	246.91	352.73
107	Lime, nitrogen, potassium	198.16	283.08
108	Lime, phosphorus, potassium	204.90	292.71
109	Lime, nitrogen, phosphorus, potassium	257.91	368.45
110	Nitrogen, phosphorus, potassium	242.47	346.38
	Value of Increase per Acre in Twelve Years		
	For nitrogen	$–9.07	$–12.96
	For phosphorus	31.27	44.66
	For *nitrogen* and phosphorus over phosphorus	29.13	41.62
	For *phosphorus* and nitrogen over nitrogen	69.47	99.24
	For *potassium*, nitrogen, and phosphorus over nitrogen and phosphorus	11.00	15.72

nually was but little in excess of the phosphorus. The untreated land apparently became less productive, whereas on land receiving both nitrogen and phosphorus the yields were appreciably increased, so that in 1907 the untreated rotated land produced only 34 bushels of corn and the land treated with lime, nitrogen, and phosphorus yielded 72 bushels per acre (more than twice as much), altho both plots produced the same yield (57.3 bushels) in 1902. The total values per acre of the twelve crops for each plot are shown in Table 2.

Here it is seen that with the lower prices phosphorus without nitrogen produced $31.27 in addition to the increase by lime, but that with nitrogen it produced $69.47 above the crop values where only lime and nitrogen have been used. The results show that in 26 cases out of 48 the addition of potassium decreased crop yields. Lime produced an average increase of $14.53, or $1.21 an acre per year; which shows that the time has come when limestone must be applied to some of the brown silt loam soils. (Detailed data in regard to crop yields will be found in Soil Report No. 10, McLean county.)

Bloomington Field.—The results of thirteen years' work on the experiment field located near Bloomington on brown silt loam prairie soil are much the same as those from the Sibley field, as may be seen from Table 3.

The treatment of this field differs from that at Sibley in that in 1905 the use of commercial nitrogen was discontinued, clover was introduced into the rotation, and crop residues were subsequently returned to the soil. With this method, phosphorus has produced even

TABLE 3.—VALUE OF CROPS PER ACRE IN THIRTEEN YEARS, BLOOMINGTON FIELD 1902 TO 1914

Plot	Soil treatment applied	Total value of 13 crops	
		Lower prices	Higher prices
101	None	$186.83	$266.90
102	Lime	186.76	266.80
103	Lime, residues	193.83	276.90
104	Lime, phosphorus	286.61	409.45
105	Lime, potassium	190.53	272.19
106	Lime, residues, phosphorus	285.03	407.19
107	Lime, residues, potassium	191.10	273.00
108	Lime, phosphorus, potassium	294.91	421.31
109	Lime, residues, phosphorus, potassium	284.47	406.39
110	Residues, phosphorus, potassium	259.10	370.15
	Value of Increase per Acre in Thirteen Years		
	For residues	$ 7.07	$ 10.10
	For phosphorus	99.85	142.65
	For *residues* and phosphorus over phosphorus	−1.58	−2.26
	For *phosphorus* and residues over residues	91.20	130.29
	For *potassium*, residues, and phosphorus over residues and phosphorus	−.56	−.80

larger increases ($99.85) than have been produced by phosphorus and nitrogen over nitrogen on the Sibley field ($69.47). The average yearly increase due to phosphorus in connection with the use of legume

TABLE 4.—YIELDS PER ACRE, THREE-YEAR AVERAGES, URBANA FIELD

First Rotation: 1902-1904

Serial plot No.	Soil treatment	Corn *bu.*	Oats *bu.*	Hay *tons*	Value of 3 crops	
					Lower prices	Higher prices
1	None	75.4	48.8	.49	$43.48	$62.12
2	Legume cover crop	77.4	45.1	.44	42.80	61.14
3	None	75.3	50.4	.41	43.33	61.91
4	Legume cover crop, lime	78.4	47.3	.42	43.62	62.32
5	Lime	80.8	58.2	.44	47.66	68.08
6	Legume cover crop, lime, phosphorus	88.0	52.5	.50	49.00	70.00
7	Lime, phosphorus	88.8	56.6	.98	53.79	76.84
8	Legume cover crop, lime, phosphorus, potassium	90.1	48.3	.64	49.53	70.77
9	Lime, phosphorus, potassium	90.5	54.3	1.34	56.26	80.37
10	Lime, phosphorus, potassium	86.5	53.2	1.23	53.78	76.83

Second Rotation: 1905-1907

Serial plot No.	Soil treatment	Corn *bu.*	Oats *bu.*	Clover *tons*	Value of 3 crops	
					Lower prices	Higher prices
1	None	71.5	46.6	2.07	$52.56	$75.09
2	Legume cover crop	68.5	52.0	1.83	51.34	73.35
3	Manure	80.5	54.8	2.19	58.84	84.07
4	Legume cover crop, lime	72.3	58.6	1.98	55.57	79.39
5	Manure, lime	84.8	59.8	2.46	63.64	90.92
6	Legume cover crop, lime, phosphorus	90.4	70.7	2.69	70.26	100.38
7	Manure, lime, phosphorus	93.2	71.6	3.47	76.96	109.94
8	Legume cover crop, lime, phosphorus, potassium	93.8	71.7	3.06	74.32	106.18
9	Manure, lime, phosphorus, potassium	95.6	66.9	3.73	78.30	111.86
10	Manure (x), lime, phosphorus (x)	90.1	62.9	2.86	69.17	98.81

Third Rotation: 1908-1910

Serial plot No.	Soil treatment	Corn *bu.*	Oats *bu.*	Clover *tons* (*bu.*)	Value of 3 crops	
					Lower prices	Higher prices
1	None	49.4	40.8	2.30	$44.81	$64.02
2	Residues	51.5	43.4	(1.93)	43.69	62.41
3	Manure	69.3	46.2	2.53	54.90	78.43
4	Residues, lime	58.1	45.7	(2.02)	47.27	67.53
5	Manure, lime	74.9	47.5	2.94	60.09	85.85
6	Residues, lime, phosphorus	83.8	54.5	(2.64)	63.07	90.10
7	Manure, lime, phosphorus	86.6	55.4	4.17	75.01	107.16
8	Residues, lime, phosphorus, potassium	86.7	53.5	(1.99)	59.26	84.65
9	Manure, lime, phosphorus, potassium	90.9	53.6	3.90	74.12	105.89
10	Manure (x), lime, phosphorus (x)	81.3	54.3	3.79	70.19	100.27

X=extra heavy applications of manure and phosphorus; residues=corn stalks, straw of wheat and oats, and all legumes except seed.

TABLE 5.—YIELDS PER ACRE, FOUR-YEAR AVERAGES, URBANA FIELD 1911 TO 1914

Serial plot No.	Soil treatment	Wheat *bu.*	Corn *bu.*	Oats *bu.*	Soybeans–3 *tons (bu.)*	Clover–1 *tons (bu.)*	Alfalfa *tons*	Value of 5 crops	
								Lower prices	Higher prices
1	0.....	18.3	50.8	39.8	1.60	1.70	1.70	$65.00	$92.87
2	R.....	19.7	53.8	40.6	(20.1)	(.74)	1.27	64.72	92.47
3	M.....	20.3	59.3	48.8	1.60	1.43	1.13	67.44	96.35
4	RL....	22.3	55.7	42.8	(19.0)	(1.03)	1.19	67.20	96.00
5	ML....	24.9	58.6	51.6	1.66	1.94	1.67	76.19	108.84
6	RLP...	37.4	62.2	58.7	(21.0)	(2.48)	2.69	98.58	140.83
7	MLP...	36.6	63.8	60.9	1.88	2.90	2.63	98.36	140.51
8	RLPK.	36.1	58.9	59.1	(22.2)	(1.41)	2.58	94.61	135.16
9	MLPK.	35.3	59.6	65.1	2.09	2.72	2.66	98.15	140.22
10	MxLPx.	43.5	55.7	67.2	2.14	2.94	2.84	105.02	150.03

Le=legume cover crop; L=lime; P=phosphorus; M=manure; x=extra heavy applications of manure and phosphorus; R=crop residues (corn stalks, straw of wheat and oats, and all legumes except seed and alfalfa hay).

crops or nitrogen has been $7.02 an acre, which is $4.52 above the cost of phosphorus in 200 pounds of steamed bone meal, the form in which it is applied. The total phosphorus applied from 1902 to 1914, as an average of all plots where it has been used, has amounted to 325 pounds per acre and has cost $32.50. This has paid back $97.20, or 300 percent on the investment. Potassium, on the other hand, has paid back less than 7 percent of its cost in the thirteen years. (Detailed data in regard to crop yields will be found in Soil Report No. 10, McLean county.)

Urbana Field.—On the University North Farm at Urbana, on the common brown silt loam prairie soil, a rotation of corn, oats, and clover was practiced for nine years (1902 to 1910), which has been followed by a combination rotation involving corn, oats, clover, wheat, and alfalfa. The various plots upon each series are so treated as to show the value of various additions in both live-stock and grain farming. On all series, Plot 10 is treated with about five times as much manure and phosphorus as is applied on the other plots, in order to remove the limitations of inadequate fertility and thus to determine the climatic possibilities of crop yields. Tables 4 and 5 give the three-year and the four-year averages, respectively, of crop yields and the value of the crops by rotations, with both the higher and the lower prices. No detailed discussion of this interesting data will be given here (see Soil Report No. 9, Lake county, or No. 10, McLean county), but a few points of interest will be indicated for further study.

While seasonal variations are inevitable, a comparison of crop yields by rotations, with and without soil treatment, is instructive. On the untreated land distinctly higher average yields of corn appear in the first rotation than in succeeding rotations, as 75.4 bushels in the first and 49.4 bushels in the last of the three-year rotations. The

difference in yields of corn between treated and untreated land becomes greater with succeeding rotations, as is seen by the difference of 13.4 bushels between Plots 1 and 7 in the first rotation, and of 37.2 bushels between the same plots in the last of the three-year rotations. Such evidence points to the fact that fertility cannot be maintained by rotation alone, but that with a good system of soil treatment maximum production may be expected indefinitely.

Attention is also called to the striking effects of soil treatment upon the wheat yields, which show 100 percent increase, as an average, during the four-year rotation. At the lower prices for produce, farm manure has been worth 84 cents per ton during the ten years it has been used on Plot 3.

As a general average, the plots receiving limestone have produced $1.22 an acre a year more than the plots not receiving limestone, and this corresponds to more than $6 a ton for all the limestone applied;

FIG. 6.—METHOD OF SCATTERING LIMESTONE AND PHOSPHORUS[1]

but the amounts of limestone applied before 1911 were so small and the results so variable that final conclusions cannot be drawn until further data are secured. However, since all comparisons of rotation periods show some increase, the need of limestone for the best results and the highest profits seems well established.

Potassium applied at an estimated cost of $2.50 an acre a year seemed to produce slight increases, on the average, during the first and second rotations, but the net result thru the 1914 yields was an

[1]For description of this machine, see page 16 of Circular 110 of this station.

average loss of $2.53 per acre per annum, including the cost of the potassium.

The annual application of 25 pounds of phosphorus in 200 pounds of steamed bone meal valued at $28 per ton, or of 75 pounds in 600 pounds of rock phosphate valued at $7 per ton, in connection with decaying organic manures, has, as an average for each dollar invested in phosphorus, paid as follows:

	Lower prices	Higher prices
First rotation, 1902–1904	$ .69	$ .99
Second rotation, 1905–1907	1.67	2.39
Third rotation, 1908–1910	2.09	2.99
Fourth rotation, 1911–1914	2.19	3.13

The excessive applications on Plot 10 have usually produced rank growth of straw and stalk, with the result that oats have often lodged badly and corn has frequently suffered from drouth and has eared poorly. Wheat, however, as an average, has yielded best on this plot. The largest yield of corn was 118 bushels per acre in 1907.

On the University South Farm at Urbana, on typical brown silt loam prairie, where one ton per acre of rock phosphate is applied every four years in connection with organic manures for a rotation of corn, oats, clover, and wheat, applications of fine-ground rock phosphate have paid as follows in the value of the increase produced:

	Per Ton of Phosphate		Per $1 Invested	
	Lower prices	Higher prices	Lower prices	Higher prices
First rotation, 1903–1906	$ 8.26	$11.80	$ 1.18	$ 1.69
Second rotation, 1907–1910	11.33	16.19	1.62	2.31
Third rotation, 1911–1914	18.89	26.98	2.70	3.85

The comparative values of the increases from rock phosphate and limestone, as an average of the four-year rotation 1911-1914, in both live-stock and grain farming, are as follows:

	Residue System		Live-stock System	
	Lower prices	Higher prices	Lower prices	Higher prices
Gain for phosphorus	$18.80	$26.86	$18.96	$27.09
Gain for limestone	2.30	3.29	2.54	3.63

Brown-Gray Silt Loam on Tight Clay of Middle Illinoisan Glaciation (428)

Mascoutah Field.—Table 6, showing the value of twelve crops from the Mascoutah experiment field located upon brown-gray silt loam on tight clay of the middle Illinoisan glaciation, are given here since there is no data for this type in either the lower or the upper Illinoisan glaciation. In order to secure information as quickly as possible, commercial plant foods in readily available form were applied in a four-year rotation of corn, corn, oats, and wheat.

TABLE 6.—VALUE OF CROPS PER ACRE IN TWELVE YEARS, MASCOUTAH FIELD 1902 TO 1913

Plot	Soil treatment applied	Total value of 12 crops	
		Lower prices	Higher prices
501	None	$90.07	$128.67
502	Lime	90.47	129.24
503	Lime, nitrogen	134.46	192.08
504	Lime, phosphorus	106.10	151.57
505	Lime, potassium	100.96	144.23
506	Lime, nitrogen, phosphorus	190.55	272.21
507	Lime, nitrogen, potassium	205.60	293.72
508	Lime, phosphorus, potassium	123.84	176.92
509	Lime, nitrogen, phosphorus, potassium	190.67	272.39
510	Nitrogen, phosphorus, potassium	177.58	253.69
	Value of Increase per Acre in Twelve Years		
	For nitrogen	$43.99	$62.84
	For phosphorus	15.63	22.33
	For *nitrogen* and phosphorus over phosphorus	84.45	120.64
	For *phosphorus* and nitrogen over nitrogen	56.09	80.13
	For *potassium*, nitrogen, and phosphorus over nitrogen and phosphorus	.12	.18

Nitrogen is clearly the element of greatest benefit upon this soil type, as shown by the fact that in twelve years the dried blood increased the crop values, at the lower prices, from $90.47 to $134.46, a gain of $43.99. In comparison, phosphorus produced an increase valued at $15.63 and potassium an increase of only $10.49, when used singly. In considering these three elements, starting with $90.47 (Plot 2), the increases per acre in crop values were as follows:

For nitrogen over lime	$ 43.99
For phosphorus as a further addition	56.09
For potassium as a final addition	.12
For total increase	$100.20

This demonstration of doubling crop values is highly important, for it shows the possibilities of soil treatment. From the composition of the soil it is clear that both nitrogen and phosphorus must be supplied for a permanent system of farming, altho there may be some question as to which of the two is most needed. Commercial nitrogen, altho producing marked gains, never paid its cost; and while phosphorus paid nearly 200 percent on the investment in steamed bone meal when used in addition to nitrogen, the profit is more than offset by the nitrogen deficit.

On another part of Mascoutah field investigations were conducted to secure information in regard to the practicability of securing nitrogen by the less expensive practice of growing legumes in the rotation and returning to the soil the crop residues and farm manure. A comparison of these results for eight years shows that the crop values

TABLE 7.—VALUE OF CROPS PER ACRE IN FOURTEEN YEARS, DUBOIS FIELD 1902 TO 1915: NOT TILE-DRAINED

Plot	Soil treatment applied	Total value of 14 crops	
		Lower prices	Higher prices
101	None	$63.83	$91.19
102	Lime	88.28	126.11
103	Lime, residues	113.66	162.37
104	Lime, phosphorus	145.66	208.09
105	Lime, potassium	144.97	207.10
106	Lime, residues, phosphorus	165.07	235.82
107	Lime, residues, potassium	172.34	246.20
108	Lime, phosphorus, potassium	186.02	265.75
109	Lime, residues, phosphorus, potassium	196.39	280.55
110	Residues, phosphorus, potassium	140.50	200.71
	Value of Increase per Acre in Fourteen Years		
	For lime	$24.45	$34.92
	For residues	25.38	36.26
	For phosphorus	57.38	81.98
	For *residues* and phosphorus over phosphorus	19.41	27.73
	For *phosphorus* and residues over residues	51.41	73.45
	For *potassium*, residues, and phosphorus over residues and phosphorus	31.32	44.73

at the lower prices averaged $119.38 where commercial nitrogen costing $120 was used, and $119.61 and $117.20 where residues and farm manure, respectively, were used.

These data show that practically the same gross values are secured with "home-grown" nitrogen as with the purchased product, and at much less cost. (Detailed data in regard to crop yields will be found in Soil Report 8, Bond county.)

Gray Silt Loam on Tight Clay of Lower Illinoisan Glaciation (330)

DuBois Field.—Data are presented in Tables 7 and 8 showing the results of soil experiments and tile drainage upon gray silt loam on tight clay, the common prairie soil of southern Illinois.

A summary of these data shows that tile drainage has paid $6.37 per acre in fourteen years, or 45 cents per acre per year. It would require at least $1.20 per acre per year to pay 6 percent interest on the cost of the tile drainage, assumed to be $20 per acre.

A summary of the average results from the tiled and the untiled land for the fourteen years shows a crop value of $63.40 per acre from the unfertilized land, and increases for additions as follows:

For lime alone	$30.39	or 48	percent
For nitrogen and organic matter over lime	24.26	or 26	"
For phosphorus as a further addition	54.39	or 46	"
For potassium as a final addition	22.37	or 13	"
For total increase over untreated land	$131.41	or 207	percent

TABLE 8.—VALUE OF CROPS PER ACRE IN FOURTEEN YEARS, DUBOIS FIELD 1902 TO 1915: TILE-DRAINED

Plot	Soil treatment applied	Total value of 14 crops	
		Lower prices	Higher prices
111	None	$62.98	$89.97
112	Lime	99.32	141.89
113	Lime, residues	122.47	174.96
114	Lime, phosphorus	136.54	195.06
115	Lime, potassium	146.48	209.26
116	Lime, residues, phosphorus	179.84	256.89
117	Lime, residues, potassium	181.45	259.22
118	Lime, phosphorus, potassium	193.43	276.33
119	Lime, residues, phosphorus, potassium	193.26	276.08
120	Residues, phosphorus, potassium	164.70	235.29
	Value of Increase per Acre in Fourteen Years		
For lime		$36.34	$51.92
For residues		23.15	33.07
For phosphorus		37.22	53.17
For *residues* and phosphorus over phosphorus		43.30	61.83
For *phosphorus* and residues over residues		57.37	81.93
For *potassium*, residues, and phosphorus over residues and phosphorus		13.42	19.19

These results harmonize with those that would be expected from the chemical composition of the soil. It is likely that as the organic-matter content of the soil increases, the effect of the potassium will be diminished.

Fairfield Field.—Upon the experiment field located near Fairfield, Wayne county, on typical gray silt loam on tight clay, a four-year rotation of corn, cowpeas or soybeans, wheat, and clover is practiced upon four independent series of plots. Live-stock and grain farming, with the use of limestone and rock phosphate, are practiced upon tiled and untiled land. In Table 9 the results from the field as a whole for eight years are concisely summarized by rotations. (For more detailed information, see Soil Report No. 8, Bond county.)

Here untreated well-rotated land produced $19.69 per acre in four years at the lower values, while the land receiving farm manure, ground limestone, and fine-ground raw rock phosphate produced $53.04 in the second rotation. If it costs $5 an acre a year to farm the untreated land, the returns lack 8 cents of paying the cost, leaving nothing for taxes and interest; moreover this land is becoming poorer each year.

From the standpoint of tile drainage the value of the increase, at the lower prices, has been $1.08 per acre for each of the eight years. It would take at least $1.50 an acre a year to pay 6 percent interest on the cost of the tile drainage at $25 per acre. During the last four years of tile drainage, the increase was $1.79 per acre per

TABLE 9.—CROP VALUES PER ACRE, FAIRFIELD FIELD
1905 TO 1912

First Rotation: Average of Four Series

Soil treatment.	None		Farm manure		Limestone Phosphate		Farm manure Limestone Phosphate	
	Lower prices	Higher prices	Lower prices	Higher prices	Lower prices	Higher prices	Lower prices	Higher prices
Value of 4 crops	$19.69	$28.14	$24.34	$34.76	$26.91	$38.44	$36.42	$52.03

Second Rotation: Average of Four Series

Soil treatment.	Crop residues		Farm manure		Crop residues Limestone Phosphate		Farm manure Limestone Phosphate	
	Lower prices	Higher prices	Lower prices	Higher prices	Lower prices	Higher prices	Lower prices	Higher prices
Value of 4 crops	$20.25	$28.92	$25.45	$36.36	$38.14	$54.49	$53.04	$75.79

year, which would pay a fair rate of interest providing the cost of the drainage did not exceed $30 per acre. Tile drainage may ultimately prove to be profitable.

UPLAND TIMBER SOILS

Yellow-Gray Silt Loam of Lower Illinoisan Glaciation (334)

Raleigh Field.—Upon the experiment field located at Raleigh, Saline county, on typical yellow-gray silt loam, a four-year rotation of wheat, corn, oats and clover (or cowpeas or soybeans) is practiced. As an average of duplicate trials each year, the crop values for the years 1911-1914 from four acres were, at the lower prices, $16.44 from untreated land, $18.22 where organic manures were applied in proportion to the amount of crops produced, and $33.58 where 6 tons per acre of limestone and organic manure were applied. Owing to the low supply of organic matter, phosphorus produced almost no benefit. However, with increasing applications of organic matter the effect of phosphorus is becoming more apparent.

Yellow-Gray Silt Loam of Late Wisconsin Glaciation (1234)

Antioch Field.—The Antioch experiment field located upon yellow-gray silt loam of the late Wisconsin glaciation was so planned that the effect of various additions might be known as quickly as possible. The elements nitrogen, phosphorus, and potassium were applied in commercial form until 1911, after which commercial nitrogen was discontinued and crop residues substituted.

Altho the soil is somewhat irregular and some abnormal seasons

TABLE 10.—VALUE OF CROPS PER ACRE IN THIRTEEN YEARS, ANTIOCH FIELD 1902 TO 1914

Plot	Soil treatment applied	Total value of 13 crops	
		Lower prices	Higher prices
101	None	$135.12	$193.03
102	Lime	119.74	171.06
103	Lime, nitrogen	124.70	178.15
104	Lime, phosphorus	202.20	288.85
105	Lime, potassium	138.88	198.40
106	Lime, nitrogen, phosphorus	179.41	256.31
107	Lime, nitrogen, potassium	133.54	190.77
108	Lime, phosphorus, potassium	201.35	287.65
109	Lime, nitrogen, phosphorus, potassium	191.22	273.18
110	Nitrogen, phosphorus, potassium	181.18	258.83
	Value of Increase per Acre in Thirteen Years		
	For nitrogen	$ 4.96	$ 7.09
	For phosphorus	82.46	117.79
	For *nitrogen* and phosphorus over phosphorus	-22.79	-32.54
	For *phosphorus* and nitrogen over nitrogen	54.71	78.16
	For *potassium*, nitrogen, and phosphorus over nitrogen and phosphorus	11.81	16.87

have caused almost complete crop failures, the general summary strongly confirms the analytical data in showing the need of applying phosphorus, and the profit from its use, and the loss in adding potassium.

In most cases commercial nitrogen damaged the small grains by causing the crop to lodge. From the results of other fields we must conclude that better yields are to be secured by providing nitrogen by means of farm manure and legume crops grown in rotation than by the use of commercial nitrogen, which is evidently too readily available, causing too rapid growth and consequent weakness of straw. Table 10 gives the summarized results for thirteen years. (For more detailed information see Soil Report No. 9, Lake county, or No. 10, McLean county.)

Yellow Silt Loam of Unglaciated Areas (135) *of Upper Illinoisan Glaciation* (535)

Pot-Culture Experiments.—Yellow silt loam soil collected from an unglaciated area and from the upper Illinoisan glaciation was arranged in two series of ten four-gallon jars for greenhouse culture work and treated by additions in the same manner as for field-culture work.

As an average, the nitrogen applied produced a yield about eight times as large as that secured without the addition of nitrogen. To determine whether "home-grown" nitrogen would be as efficient as

commercial nitrogen, other pots were arranged, and to some commercial nitrogen was applied, and in others cowpeas were grown and turned under. The increase due to commercial nitrogen was not sufficient to cover the cost of the application. After the second crop of cowpeas had been turned under, the legume manures, as an average, made rather better results than the commercial nitrogen. These results confirm the analytical data in showing the great need for nitrogen; and they further show that such nitrogen need not be purchased.

Vienna Field.—Since yellow silt loam is subject to erosion and washing, the control of these factors is exceedingly important. The experiments carried on at Vienna, Johnson county, upon an unglaciated area of this type of soil are conducted solely in the interest of these problems. The management of this field includes deep plowing, contour plowing, the use of cover crops, the increase of the organic-matter content of the soil, and the use of limestone. Some of the results obtained upon this field are recorded in Table 11. They show that such land may be reclaimed and made to produce fair crops, which tend to increase when proper care is taken to reduce washing and limestone is used in connection with a good rotation.

TABLE 11.—CROP YIELDS PER ACRE FROM RECLAIMED ABANDONED HILL LAND VIENNA FIELD

Year	Field 1	Field 2	Field 3	Field 4
1906	Corn 20.4 bu.	Cowpeas turned		
1907	Cowpeas turned	Wheat 9.6 bu.	Clover 1.00 ton	Corn 24.4 bu.
1908	Wheat 7.9 bu.	Clover .77 ton	Corn 33.5 bu.	Cowpeas turned
1909	Clover .60 ton[1]	Corn 37.8 bu.	Cowpeas turned	Wheat 8.8 bu.
1910	Corn 38.6 bu.	Cowpeas turned	Wheat 15.6 bu.	Clover 1.53 tons
1911		Wheat 17.6 bu.		Corn 32.8 bu.

Average Yields of Crops Grown

	Corn	Wheat	Clover
1906–1908	26.1 bu.	8.8 bu.	.89 ton
1909–1911	36.4 bu.	14.0 bu.	1.07 tons

[1]The yield of clover for 1909 is estimated, the weights not having been taken because of a misunderstanding.

SWAMP AND BOTTOM-LAND SOILS

Deep Peat of Sand, Late Swamp and Bottom Lands (1401)

Manito Field.—Table 12 records the results obtained from the Manito experiment field upon deep peat soil, where experiments were begun in 1902 and discontinued in 1905. These results are in harmony with the information furnished by the analysis of peat soil as compared with the composition of ordinary normal soils. Where potassium was applied, the yield was three to four times as much as where

TABLE 12.—CORN YIELDS IN SOIL EXPERIMENTS, MANITO FIELD: 1902 TO 1905

(Bushels per acre)

Plot	Soil treatment for 1902	Corn 1902	Corn 1903	Soil treatment for 1904	Corn 1904	Corn 1905	Four crops
1	None	10.9	8.1	None	17.0	12.0	48.0
2	None	10.4	10.4	Limestone, 4000 lbs.	12.0	10.1	42.9
3	Kainit, 600 lbs.	30.4	32.4	Limestone, 4000 lbs. / Kainit, 1200 lbs.	49.6	47.3	159.7
4	Kainit, 600 lbs. / Acidulat'd bone, 350 lbs.	30.3	33.3	Kainit, 1200 lbs. / Steamed bone, 395 lbs.	53.5	47.6	164.7
5	Potassium chlorid, 200 lbs.	31.2	33.9	Potassium chlorid, 400 lbs.	48.5	52.7	166.3
6	Sodium chlorid, 700 lbs.	11.1	13.1	None	24.0	22.1	70.3
7	Sodium chlorid, 700 lbs.	13.3	14.5	Kainit, 1200 lbs.	44.5	47.3	
8	Kainit, 600 lbs.	36.8	37.7	Kainit, 600 lbs.	44.0	46.0	164.5
9	Kainit, 300 lbs.	26.4	25.1	Kainit, 300 lbs.	41.5	32.9	125.9
10	None	14.9[1]	14.9	None	26.0	13.6	69.4

[1]Estimated from 1903; no yield was taken in 1902 because of a misunderstanding.

nothing was applied. Sodium chlorid (common salt, containing no potassium) produces no results and cannot therefore take the place of the potassium salts. Applications of limestone produced no effect either alone or in combination.

Sand Soil of Sand, Late Swamp and Bottom Lands (1481)

Green Valley Field.—For six years experiments were conducted at Green Valley, Tazewell county, upon sand soils that easily drifted by wind when not protected by vegetation. During that time (1902 to 1907), a four-year rotation of corn, corn, oats, and wheat was practiced upon a series of ten plots so treated as to secure information as rapidly as possible upon the needs of the soil. The summary of the six years' results are given in Table 13.

From these results it is plain that nitrogen is the element of first importance. In fact the increase in yields was practically sufficient to cover the cost of the commercial nitrogen. Potassium is evidently the second limiting element where decaying organic matter is not provided, but the limit of potassium is very far above the nitrogen limit. Phosphorus during the six years' time produced but little increase.

From the results of other experiments, it is clear that the growing of legume crops and the use of manure (and possibly limestone) on these well-drained sand soils can well take the place of commercial nitrogen. Potassium may prove profitable, at least until more organic matter is supplied.

TABLE 13.—CROP YIELDS IN SOIL EXPERIMENTS, GREEN VALLEY FIELD 1902 TO 1907

Plot	Soil treatment applied	Corn 1902	Corn 1903	Oats 1904	Wheat 1905	Corn 1906	Corn 1907	Value of 6 crops	
		Bushels per acre						Lower prices	Higher prices
401	None	68.7	56.3	49.7	18.3	32.9	35.3	$94.35	$134.78
402	Lime	68.2	42.0	35.9	19.0	17.8	29.5	78.48	112.11
403	Lime, nitrogen	68.6	65.4	44.4	23.5	62.9	58.9	127.74	182.48
404	Lime, phosphorus	30.3	24.9	20.3	16.7	10.4	13.1	44.92	64.17
405	Lime, potassium	23.1	20.1	16.9	16.5	8.4	12.8	38.82	55.46
406	Lime, nitrogen, phosphorus	57.4	69.8	51.9	26.8	70.8	64.7	125.34	178.91
407	Lime, nitrogen, potassium	70.0	72.9	54.7	36.5	74.8	73.6	142.82	204.03
408	Lime, phosphorus, potassium	49.8	39.6	36.9	13.7	18.3	27.7	67.31	96.16
409	Lime, nitrogen, phosphorus, potassium	69.5	69.8	47.8	36.2	66.4	73.6	136.47	194.97
410	Nitrogen, phosphorus, potassium	57.2	66.1	50.0	26.5	66.0	71.9	123.97	177.10
Average gain for *nitrogen*		23.5	37.8	22.3	14.3	55.0	46.9	$73.37	$104.82
Average gain for *potassium* over nitrogen		6.8	3.8	3.1	11.2	3.8	11.8	17.88	25.54
Average gain for *phosphorus* over nitrogen		−5.9	.7	.3	1.5	−.3	2.9	.22	.32

PERMANENT AGRICULTURE

The objective which all farmers should then hold before them is the establishing of practical systems of soil management by means of which the fertility of the soil will not be impoverished but will be increased, or at least maintained, thereby making agriculture permanent.

On some soils, such as yellow silt loam, where erosion by surface washing is carried on to a great extent, a low-grade system of permanent agriculture can be maintained if some use is made of legume crops in long rotations, with much pasture. This system will furnish sufficient nitrogen and organic matter and the minerals will be maintained by the renewal of the surface soil from the subsoil by erosion. It is, however, the privilege and duty of farmers upon the common soils of the state to establish a high-grade system of permanent agriculture and hand it down to posterity. Abundant information shows that this can be done: first, by making liberal use of legume crops in a good rotation; second, by applying limestone liberally to soils that are acid or bordering upon acidity; and third, by using finely ground raw rock phosphate in amounts larger than are necessary for present needs, until the soil is well supplied with the element phosphorus.

For further and more detailed information regarding the soils of the state and methods for their improvement, the reader is urged to send to the Illinois Agricultural Experiment Station for any of the soil reports, bulletins, or circulars listed on the following page.

AVAILABLE PUBLICATIONS RELATING TO ILLINOIS SOIL INVESTIGATIONS

No. BULLETINS

76 Alfalfa on Illinois Soils. 1902 (5th ed., 1913).
157 Peaty Swamp Lands; Sand and "Alkali" Soils. 1912.
177 Radium as a Fertilizer. 1915.
181 Soil Moisture and Tillage for Corn. 1915.
182 Potassium from the Soil. 1915.
190 Soil Bacteria and Phosphates. 1916.

CIRCULARS

110 Ground Limestone for Acid Soils. 1907 (3d ed. 1912).
123 The Status of Soil Fertility Investigations. 1908.
127 Shall We Use Natural Rock Phosphate or Manufactured Acid Phosphate for the Permanent Improvement of Illinois Soils? 1909 (3d ed. 1912).
130 A Phosphate Problem for Illinois Landowners. 1909.
142 European Practice and American Theory Concerning Soil Fertility. 1910.
145 The Story of a King and Queen (Corn and Clover). 1910.
150 Collecting and Testing Soil Samples. 1911 (4th ed. 1916).
155 Plant Food in Relation to Soil Fertility. 1912.
165 Shall We Use "Complete" Commercial Fertilizers in the Corn Belt? 1912 (4th ed. 1913).
167 The Illinois System of Permanent Fertility. 1913.
168 Bread from Stones. 1913.
181 How Not to Treat Illinois Soils. 1915.
185 A Limestone Tester. 1916.
186 The Illinois System of Permanent Fertility from the Standpoint of the Practical Farmer: Phosphates and Honesty. 1916.

SOIL REPORTS

No. 1 Clay County. 1911.
No. 2 Moultrie County. 1911.
No. 3 Hardin County. 1912.
No. 4 Sangamon County. 1912.
No. 5 LaSalle County. 1913.
No. 6 Knox County. 1913.
No. 7 McDonough County. 1913.
No. 8 Bond County. 1913.
No. 9 Lake County. 1915.
No. 10 McLean County. 1915.

NOTE.—Subsequent to the preparation of this bulletin, the following soil reports have been published:

No. 11 Pike County. 1915.
No. 12 Winnebago County. 1916.
No. 13 Kankakee County. 1916.
No. 14 Tazewell County. 1916.